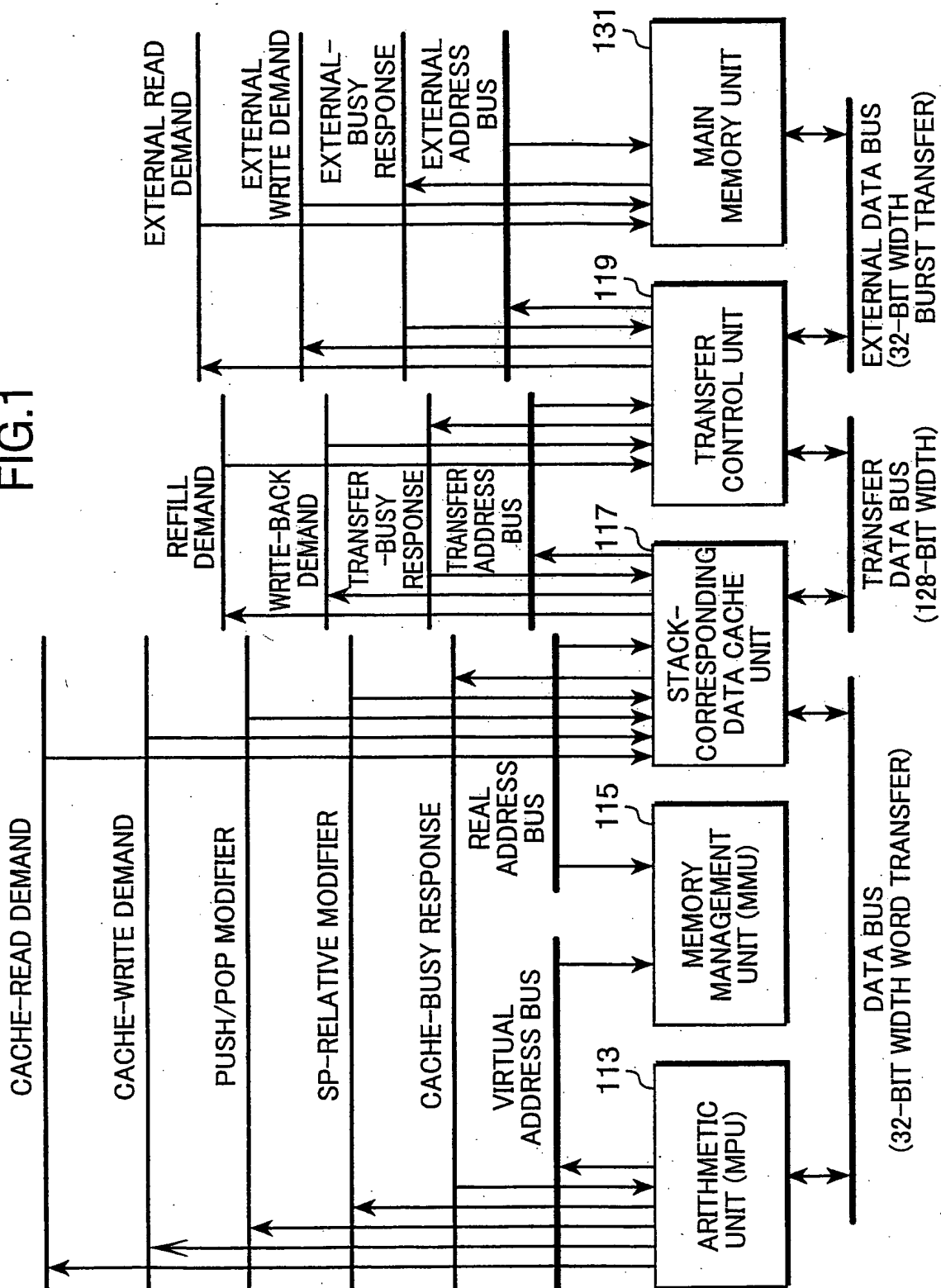


FIG.1



# FIG.2

|     | INSTRUCTION                           | OPERATION   |
|-----|---------------------------------------|---|
| (a) | PUSH Rn,[ $-R_m$ ]                    | $R_m = R_m - 4$<br>$[R_m] = R_n$<br>PUSH/POP MODIFIER=1 |
| (b) | POP [ $R_n +$ ], $R_m$                | PUSH/POP MODIFIER=1<br>$R_m = [R_n]$<br>$R_n = R_n + 4$ |
| (c) | LOAD [ $R_n + \text{OFFSET}$ ], $R_m$ | SP-RELATIVE MODIFIER=1<br>$R_m = [R_n + \text{OFFSET}]$ |
| (d) | STORE Rn,[ $R_m + \text{OFFSET}$ ]    | $[R_m + \text{OFFSET}] = R_n$<br>SP-RELATIVE MODIFIER=1 |

FIG.3

|     | CACHE-READ<br>DEMAND | CACHE-WRITE<br>DEMAND | PUSH/POP<br>MODIFIER | SP-RELATIVE<br>MODIFIER | INSTRUCTION/<br>OPERATION |
|-----|----------------------|-----------------------|----------------------|-------------------------|---------------------------|
| (a) | 0                    | 0                     | x                    | x                       | —                         |
| (b) | 0                    | 1                     | 0                    | 0                       | RANDOM WRITE              |
| (c) | 0                    | 1                     | 0                    | 1                       | SP-RELATIVE<br>WRITE      |
| (d) | 0                    | 1                     | 1                    | 0                       | PUSH                      |
| (e) | 0                    | 1                     | 1                    | 1                       | —                         |
| (f) | 1                    | 0                     | 0                    | 0                       | RANDOM READ               |
| (g) | 1                    | 0                     | 0                    | 1                       | SP-RELATIVE<br>READ       |
| (h) | 1                    | 0                     | 1                    | 0                       | POP                       |
| (i) | 1                    | 0                     | 1                    | 1                       | —                         |
| (j) | 1                    | 1                     | x                    | x                       | —                         |

FIG. 4

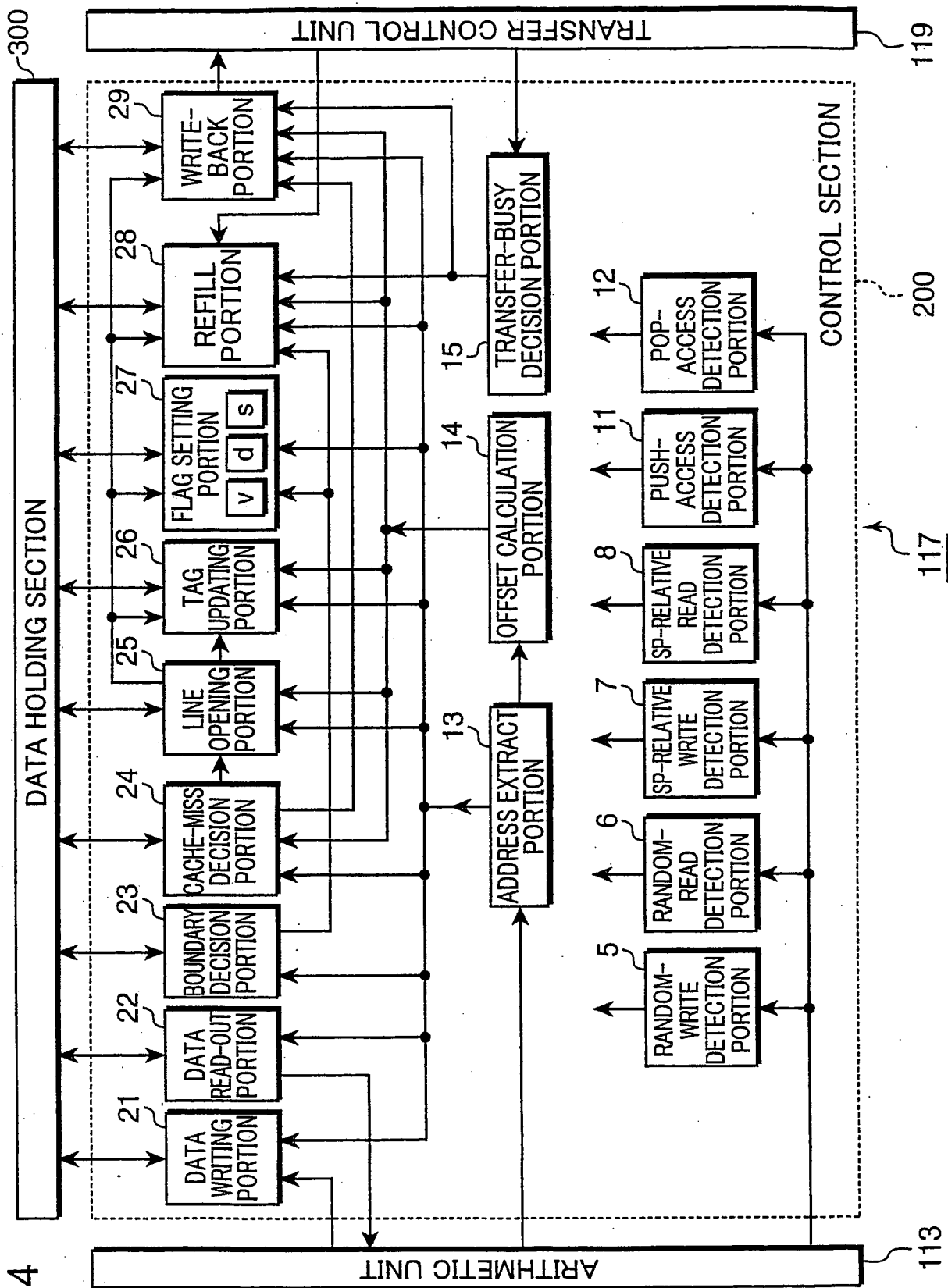


FIG.5

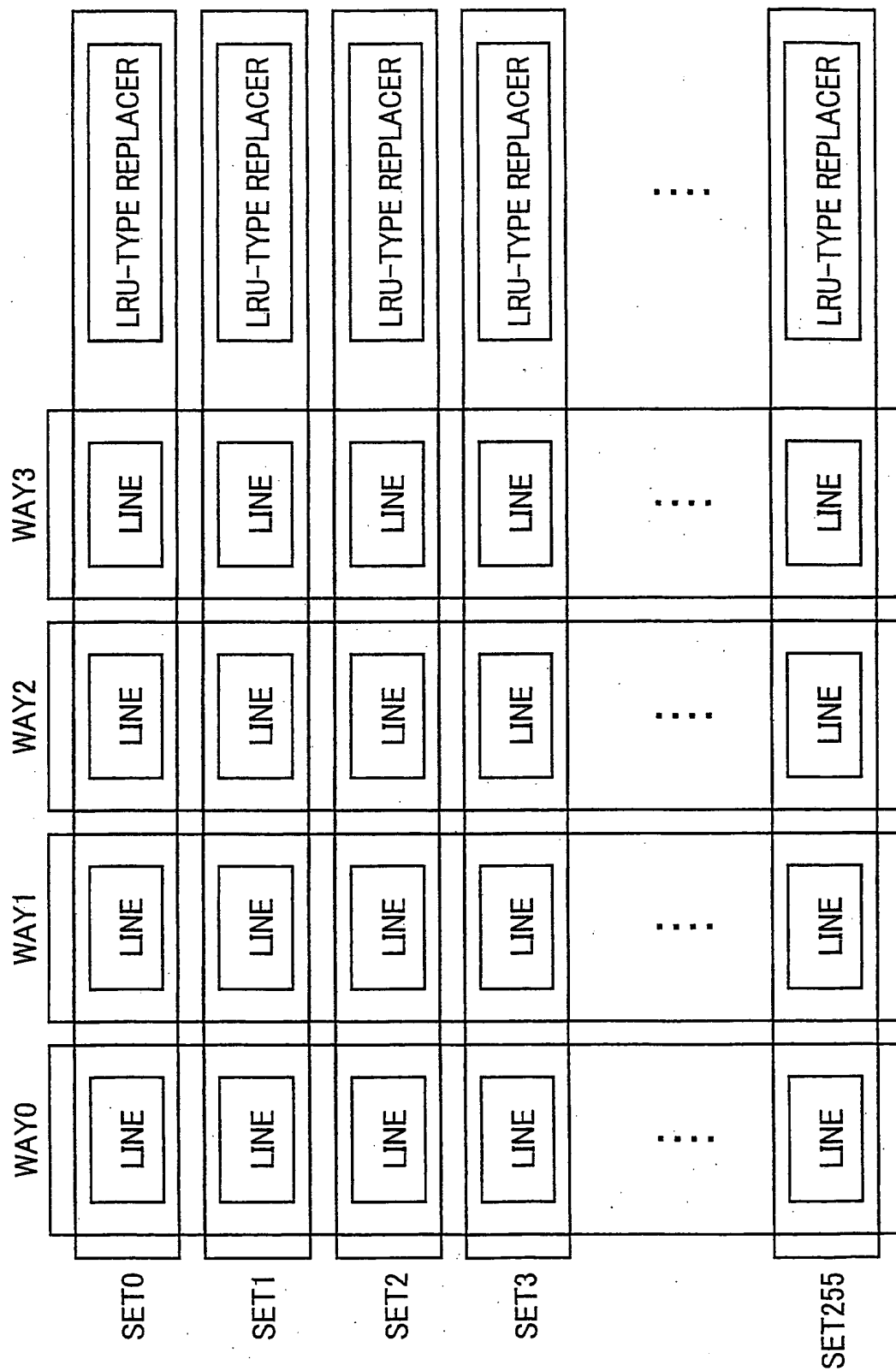


FIG.6

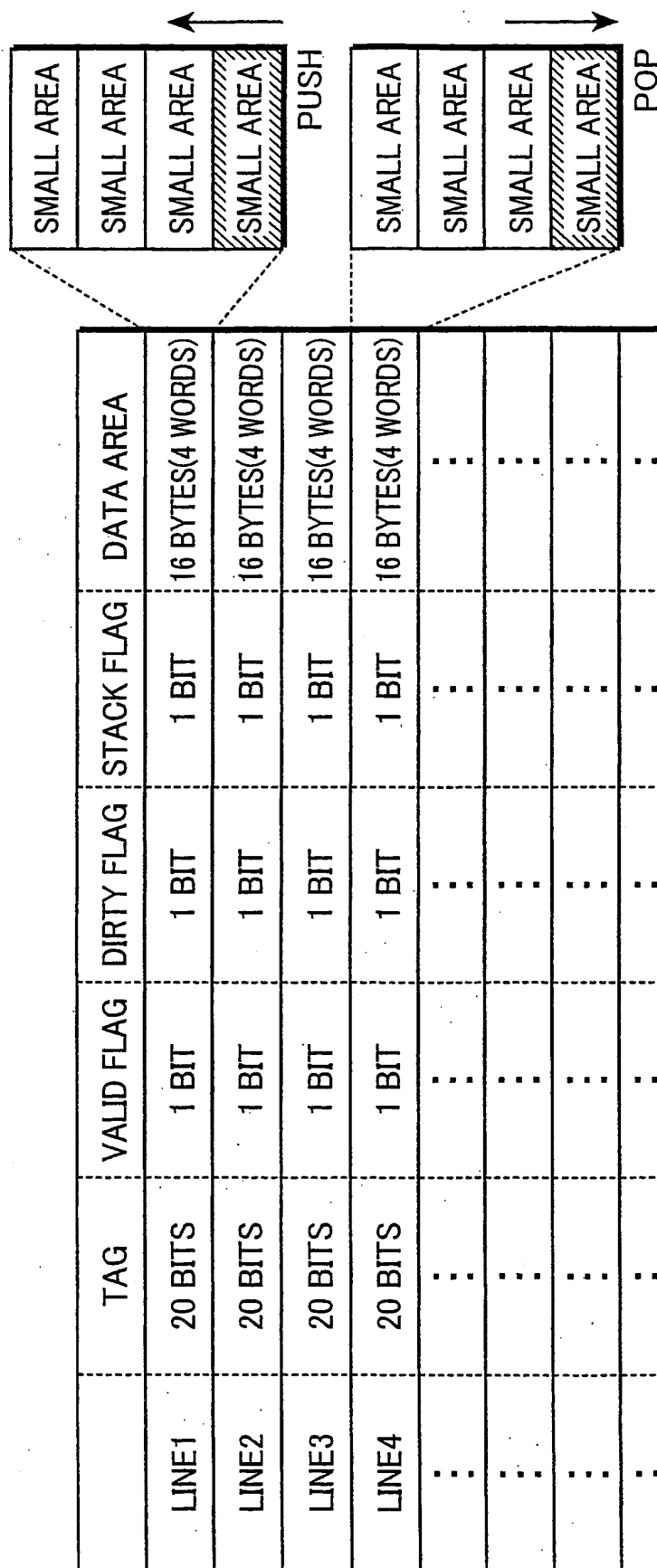


FIG.7

|     | LINE STATE |            |            | MEANING   |
|-----|------------|------------|------------|---|
|     | VALID FLAG | DIRTY FLAG | STACK FLAG |   |
| (a) | 0          | 0          | 0          | THE CONTENTS OF THE MEMORY INDICATED BY THE TAG ARE NEWER THAN THE CONTENTS OF THE LINE (THIS LINE IS NOW OPENED)   |
| (b) | 0          | 0          | 1          | THE LINE WAS ALLOCATED TO THE STACK.<br>THE CONTENTS OF THE MEMORY INDICATED BY THE TAG ARE NEWER THAN THE CONTENTS OF THE LINE (THIS LINE IS NOW OPENED) |
| (c) | 0          | 1          | 0          | —   |
| (d) | 0          | 1          | 1          | —   |
| (e) | 1          | 0          | 0          | THE CONTENTS OF THE MEMORY INDICATED BY THE TAG COINCIDE WITH THE CONTENTS OF THE LINE  |
| (f) | 1          | 0          | 1          | THE LINE IS ALLOCATED TO THE STACK.<br>THE CONTENTS OF THE MEMORY INDICATED BY THE TAG COINCIDE WITH THE CONTENTS OF THE LINE                             |
| (g) | 1          | 1          | 0          | THE CONTENTS OF THE LINE ARE NEWER THAN THE CONTENTS OF THE MEMORY INDICATED BY THE TAG   |
| (h) | 1          | 1          | 1          | THE LINE IS ALLOCATED TO THE STACK.<br>THE CONTENTS OF THE LINE ARE NEWER THAN THE CONTENTS OF THE MEMORY INDICATED BY THE TAG                            |

# FIG.8

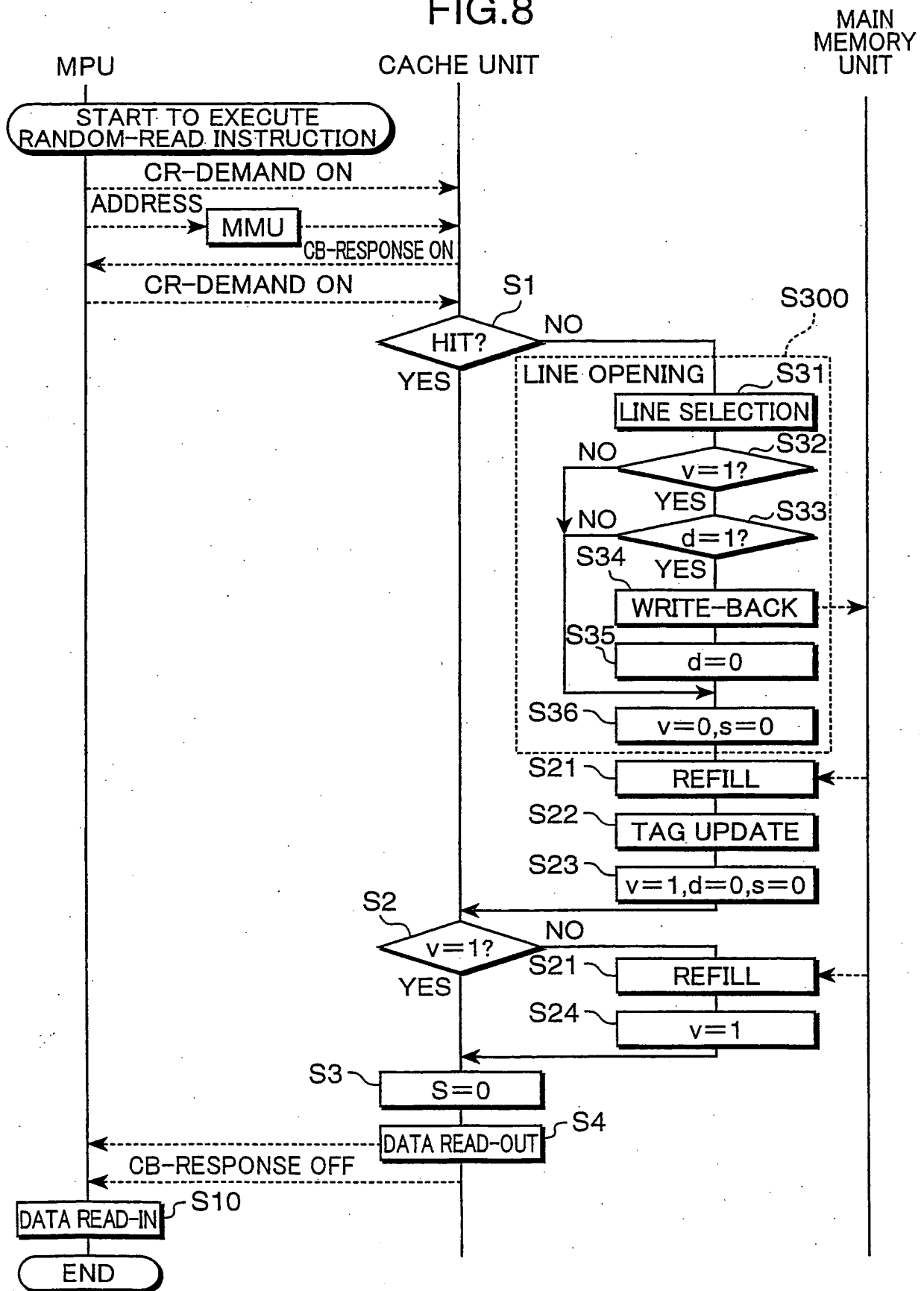




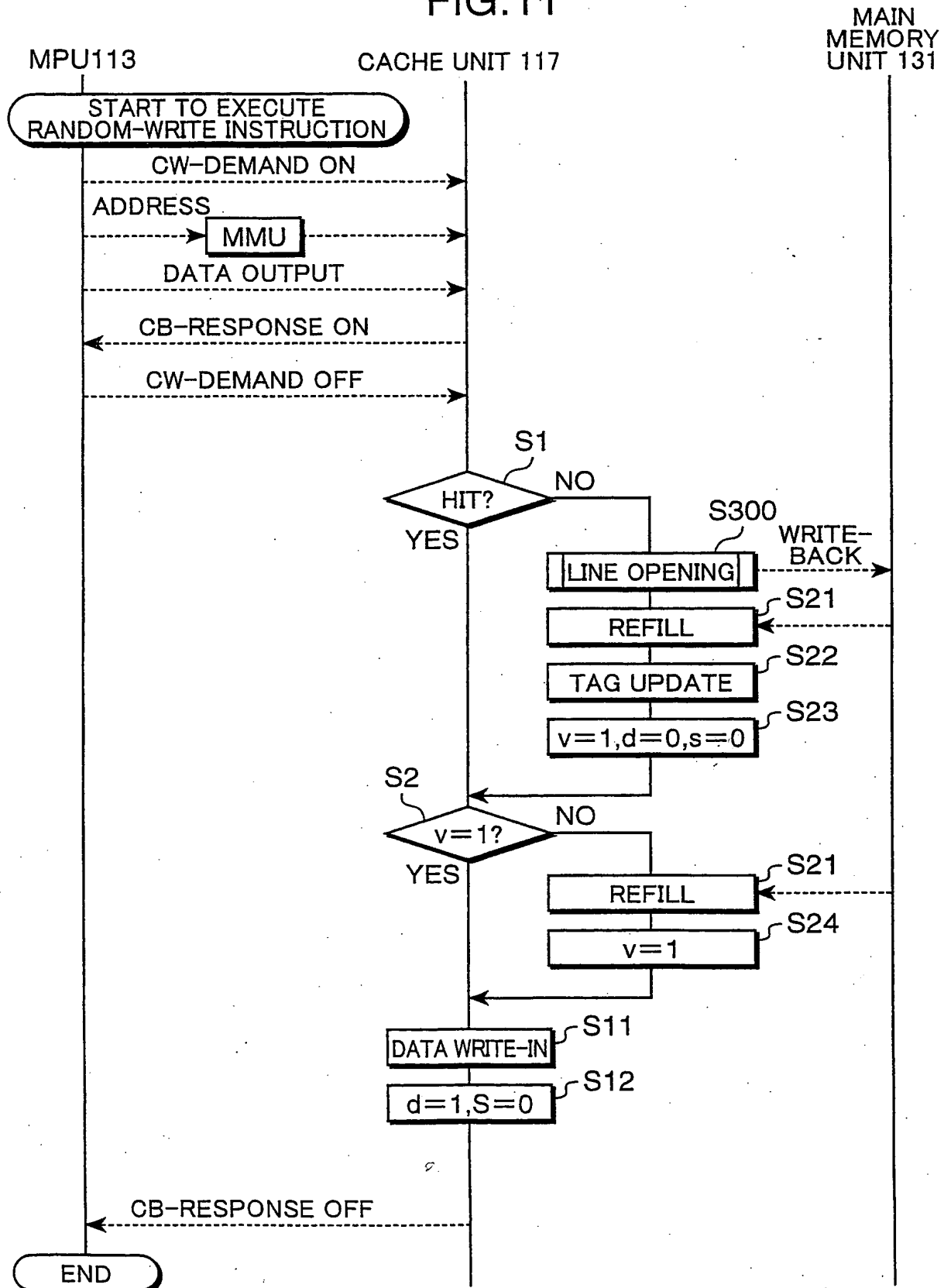
FIG.9

|     | LINE STATE    |            |            | OPERATION   |   |
|-----|---------------|------------|------------|---|---|
|     | VALID FLAG    | DIRTY FLAG | STACK FLAG | RANDOM READ   | RANDOM WRITE  |
| (a) | NOT ALLOCATED |            |            | DECISION OF THE LINE<br>TO BE OPENED,<br>OPENING OF THE<br>DECIDED LINE,<br>REFILL,<br>OPERATION OF (b) | DECISION OF THE LINE<br>TO BE OPENED,<br>OPENING OF THE<br>DECIDED LINE,<br>REFILL,<br>OPERATION OF (b) |
| (b) | 1             | 0          | 0          | DATA READ   | DATA WRITE d=1  |
| (c) | 1             | 0          | 1          | DATA READ s=0   | DATA WRITE d=1 s=0  |
| (d) | 1             | 1          | 0          | DATA READ   | DATA WRITE  |
| (e) | 1             | 1          | 1          | DATA READ s=0   | DATA WRITE s=0  |
| (f) | 0             | 0          | 0          | REFILL v=1<br>DATA READ   | REFILL v=1<br>DATA WRITE d=1  |
| (g) | 0             | 0          | 1          | REFILL v=1<br>DATA READ s=0   | REFILL v=1<br>DATA WRITE d=1 s=0  |

FIG.10

|     | LINE STATE    |            |            | OPERATION                             |                        |
|-----|---------------|------------|------------|---------------------------------------|------------------------|
|     | VALID FLAG    | DIRTY FLAG | STACK FLAG | SP MOVES UP<br>(SP-TAG $\geq$ 4WORDS) | OPENING OF THE LINE    |
| (a) | NOT ALLOCATED |            |            |                                       | —                      |
| (b) | 1             | 0          | 0          |                                       | v=0                    |
| (c) | 1             | 0          | 1          |                                       | v=0 s=0                |
| (d) | 1             | 1          | 0          |                                       | WRITE-BACK v=0 d=0     |
| (e) | 1             | 1          | 1          | WRITE-BACK d=0                        | WRITE-BACK v=0 d=0 s=0 |
| (f) | 0             | 0          | 0          |                                       |                        |
| (g) | 0             | 0          | 1          |                                       | s=0                    |

# FIG.11



# FIG.12

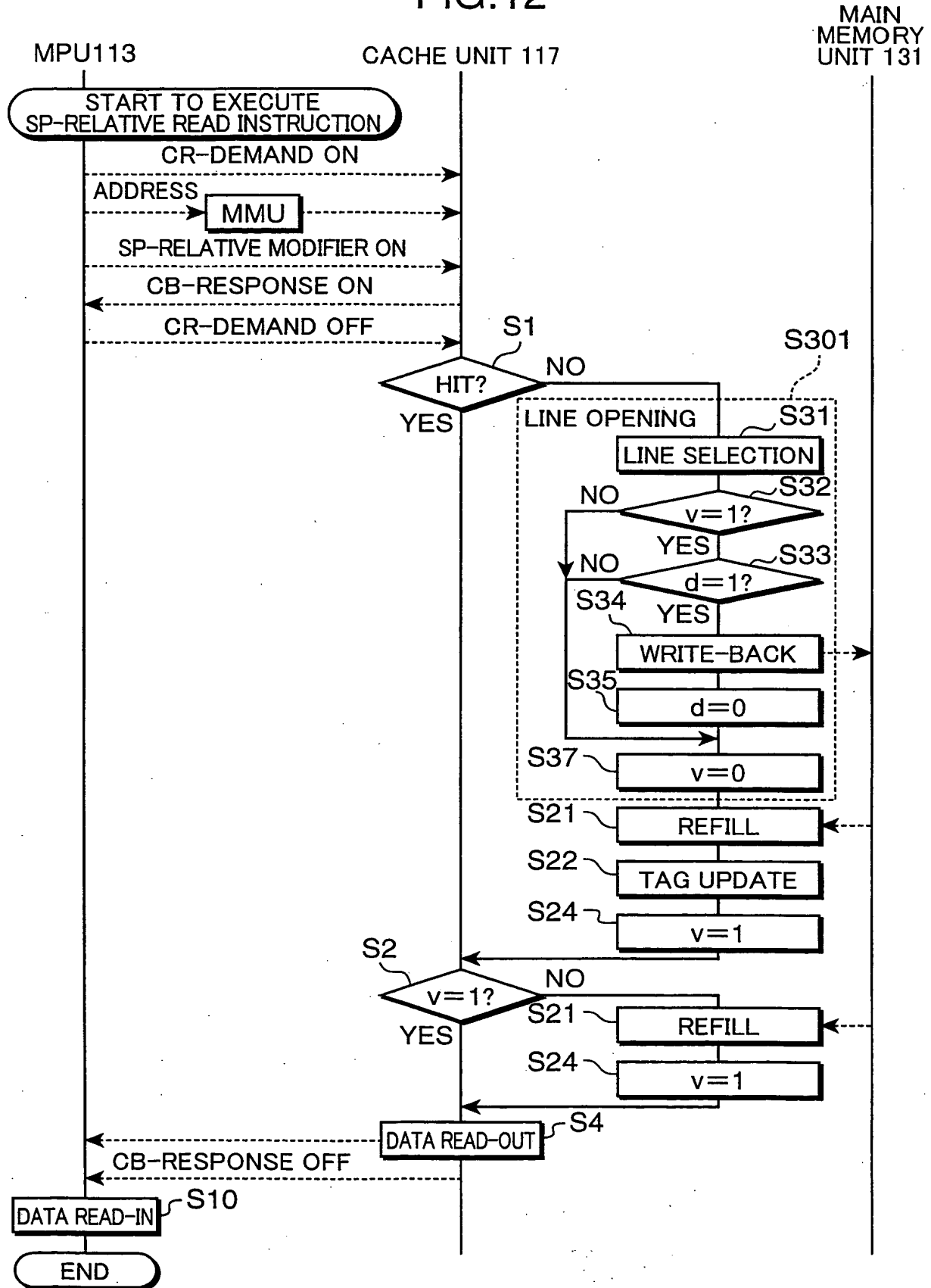
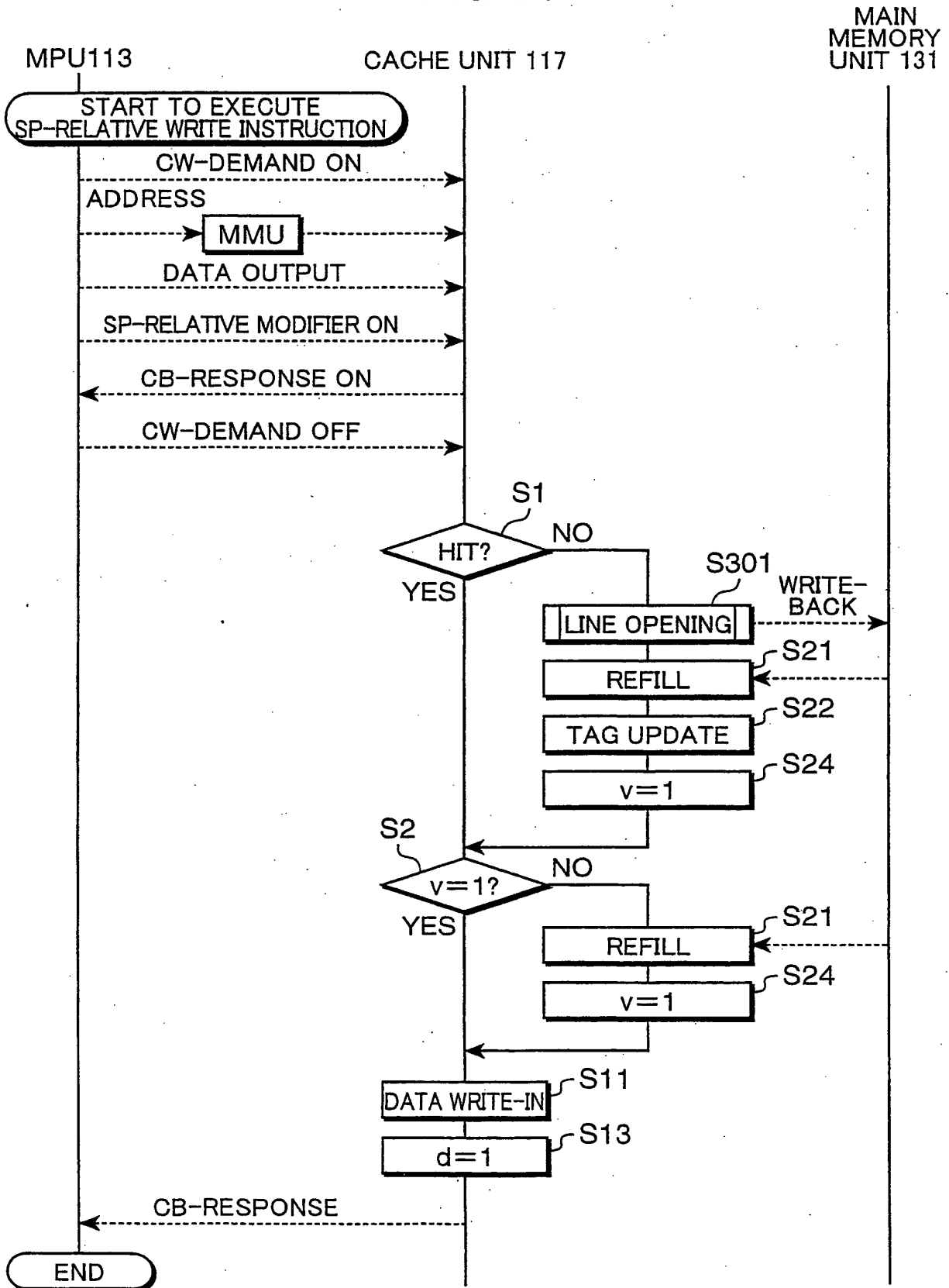


FIG.13

|     | LINE STATE    |            |            | OPERATION   |   |
|-----|---------------|------------|------------|---|---|
|     | VALID FLAG    | DIRTY FLAG | STACK FLAG | SP-RELATIVE READ  | SP-RELATIVE WRITE   |
| (a) | NOT ALLOCATED |            |            | DECISION OF THE LINE<br>TO BE OPENED,<br>OPENING OF THE<br>DECIDED LINE,<br>REFILL,<br>OPERATION OF (b) | DECISION OF THE LINE<br>TO BE OPENED,<br>OPENING OF THE<br>DECIDED LINE,<br>REFILL,<br>OPERATION OF (b) |
| (b) | 1             | 0          | 0          | DATA READ   | DATA WRITE d=1  |
| (c) | 1             | 0          | 1          | DATA READ   | DATA WRITE d=1  |
| (d) | 1             | 1          | 0          | DATA READ   | DATA WRITE  |
| (e) | 1             | 1          | 1          | DATA READ   | DATA WRITE  |
| (f) | 0             | 0          | 0          | REFILL v=1<br>DATA READ   | REFILL v=1<br>DATA WRITE d=1  |
| (g) | 0             | 0          | 1          | REFILL v=1<br>DATA READ   | REFILL v=1<br>DATA WRITE d=1  |

# FIG.14



**FIG. 15**

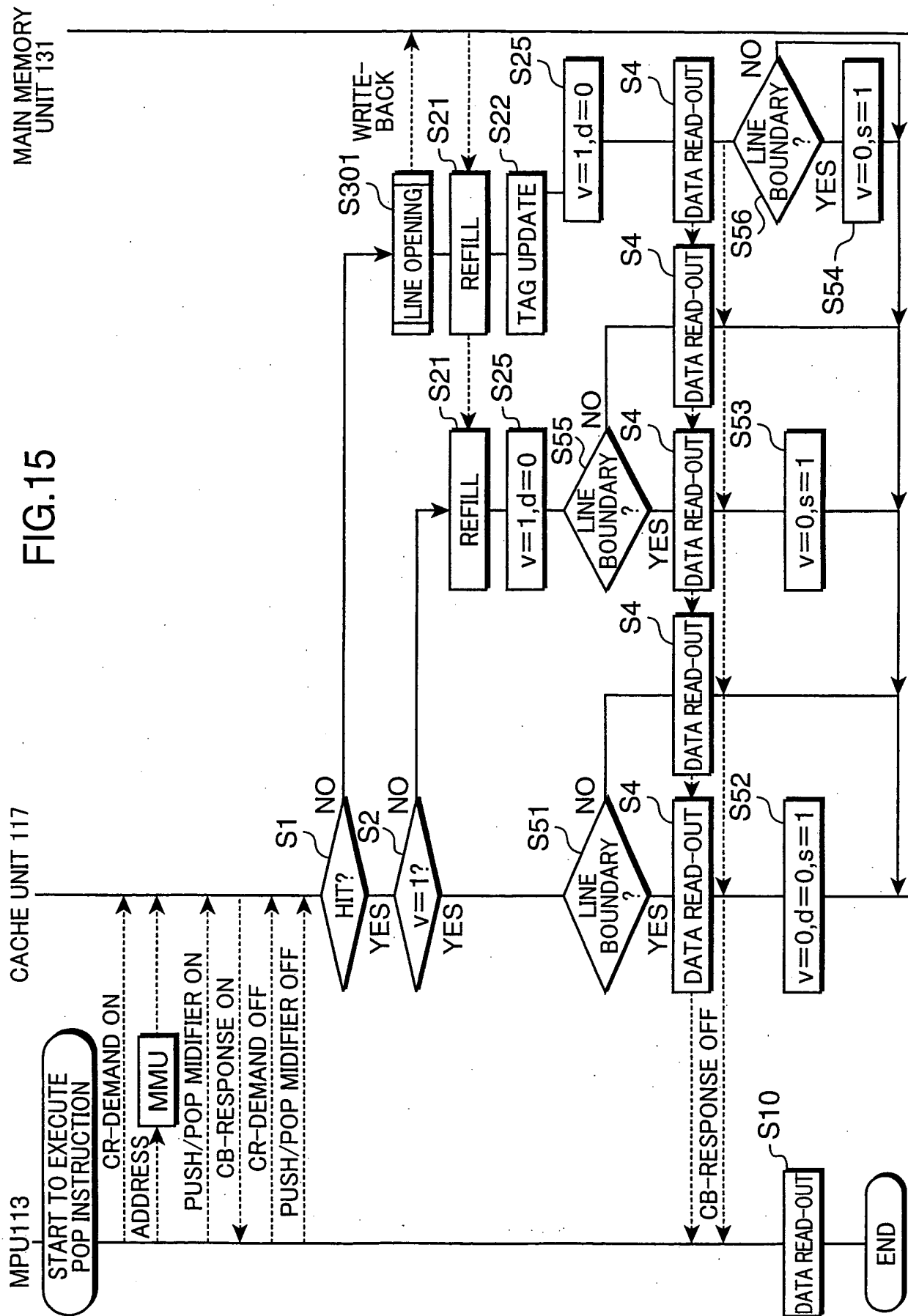


FIG.16

|     | LINE STATE    |            |            | OPERATION  |  |
|-----|---------------|------------|------------|--|--|
|     | VALID FLAG    | DIRTY FLAG | STACK FLAG | POP OUT OF THE HIGHEST ADDRESS   | POP OUT OF OTHER THAN THE HIGHEST ADDRESS  |
| (a) | NOT ALLOCATED |            |            | DECISION OF THE LINE TO BE OPENED, OPENING OF THE DECIDED LINE, REFILL, v=1 d=0 s=1, DATA READ v=0 | DECISION OF THE LINE TO BE OPENED, OPENING OF THE DECIDED LINE, REFILL, v=1 d=0, DATA READ |
| (b) | 1             | 0          | 0          | DATA READ v=0 s=1  | DATA READ  |
| (c) | 1             | 0          | 1          | DATA READ v=0  | DATA READ  |
| (d) | 1             | 1          | 0          | DATA READ v=0 d=0 s=1  | DATA READ  |
| (e) | 1             | 1          | 1          | DATA READ v=0 d=0  | DATA READ  |
| (f) | 0             | 0          | 0          | REFILL v=1<br>DATA READ v=0 s=1  | REFILL v=1<br>DATA READ  |
| (g) | 0             | 0          | 1          | REFILL v=1<br>DATA READ v=0  | REFILL v=1<br>DATA READ  |



# FIG.17

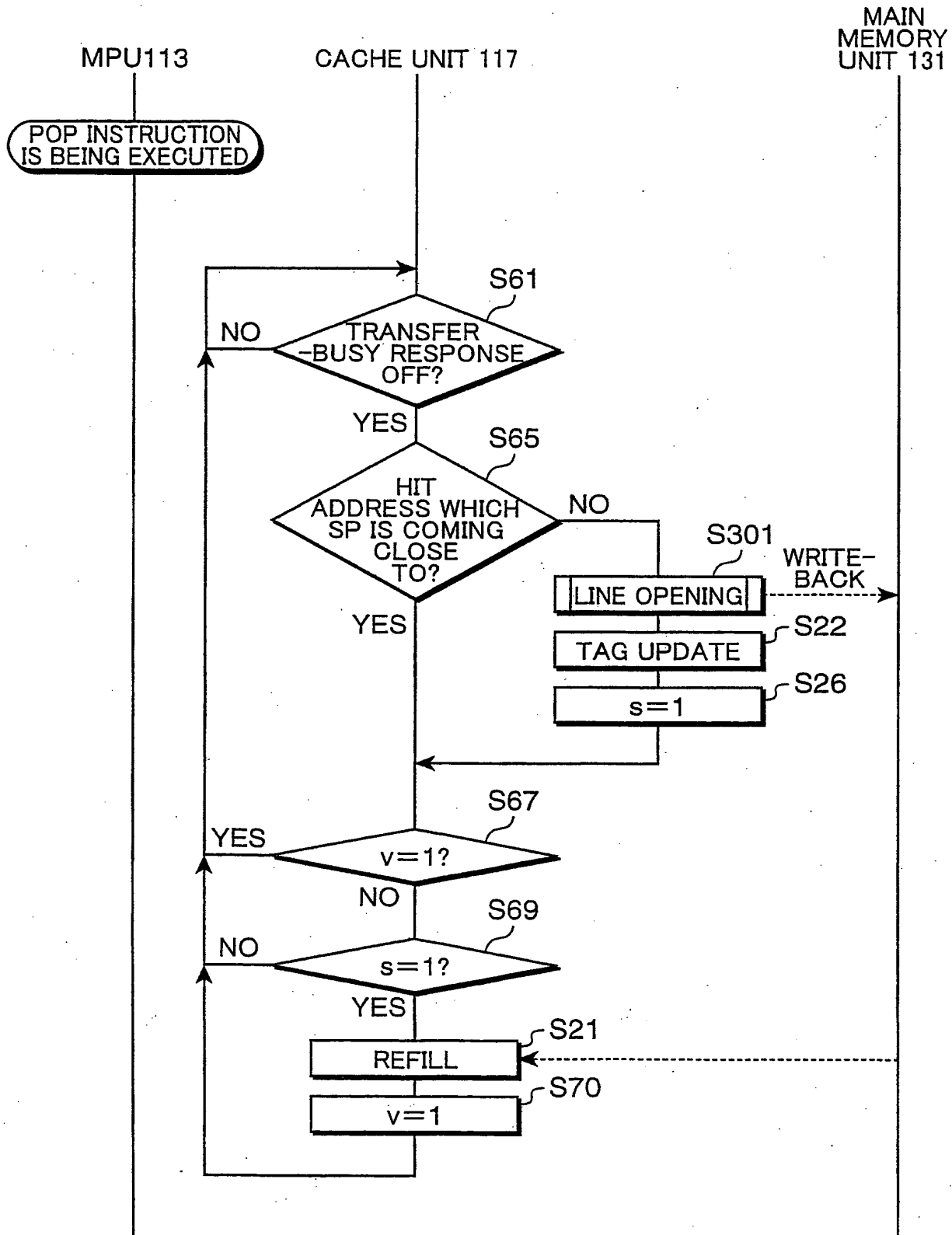
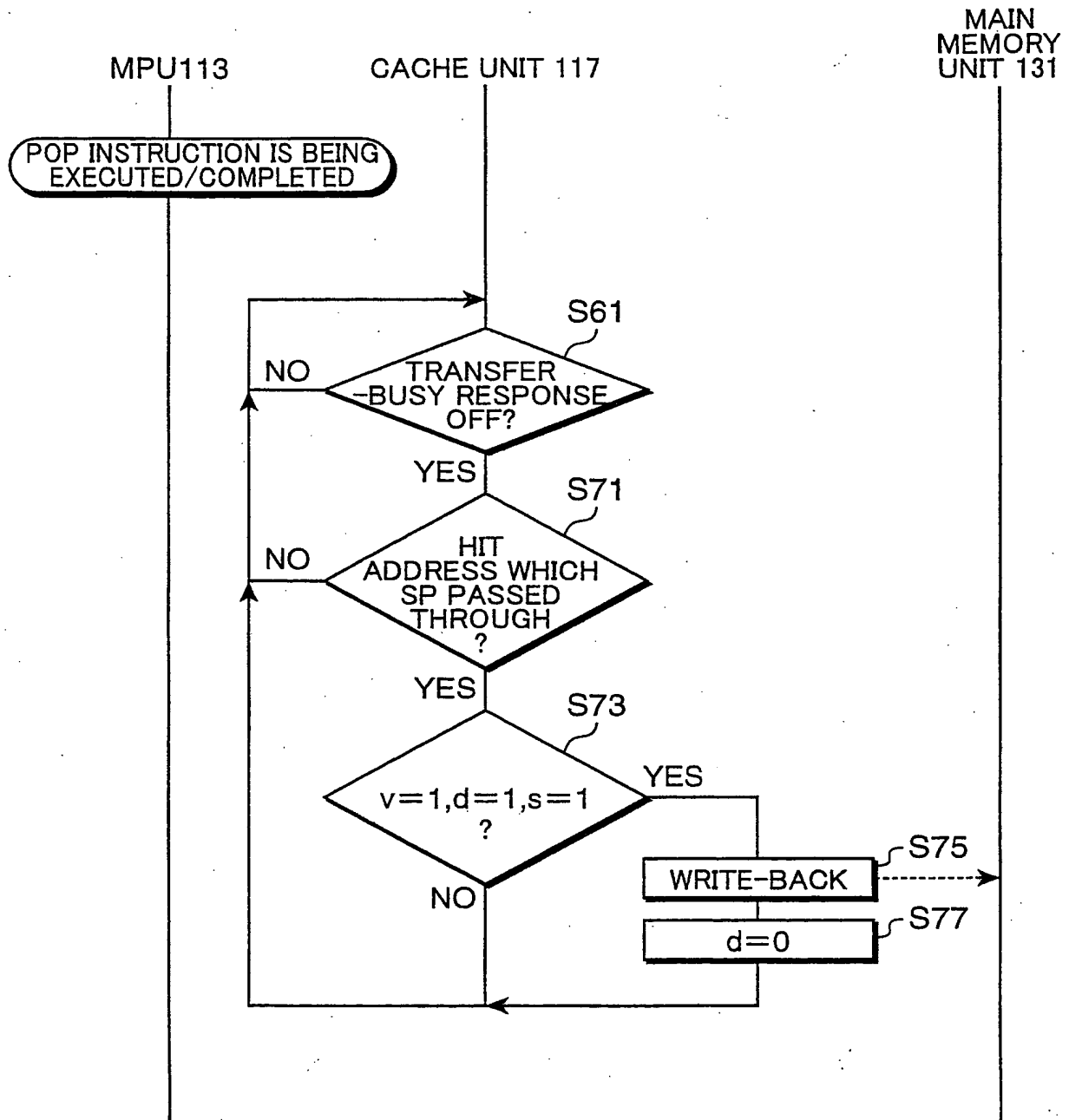


FIG.18

|     | LINE STATE    |            |            | OPERATION  |  |
|-----|---------------|------------|------------|--|--|
|     | VALID FLAG    | DIRTY FLAG | STACK FLAG | SP WENT AWAY DOWNWARD<br>(TAG-SP $\geq$ 12WORDS) | SP CAME CLOSE<br>FROM BELOW<br>(TAG-SP $\leq$ 8WORDS)  |
| (a) | NOT ALLOCATED |            |            |  | DECISION OF THE LINE<br>TO BE OPENED,<br>OPENING OF<br>THE DECIDED LINE,<br>OPERATION OF (g) |
| (b) | 1             | 0          | 0          |  |  |
| (c) | 1             | 0          | 1          |  |  |
| (d) | 1             | 1          | 0          |  |  |
| (e) | 1             | 1          | 1          | WRITE-BACK d=0                                   |  |
| (f) | 0             | 0          | 0          |  |  |
| (g) | 0             | 0          | 1          |  | REFILL v=1   |

FIG.19



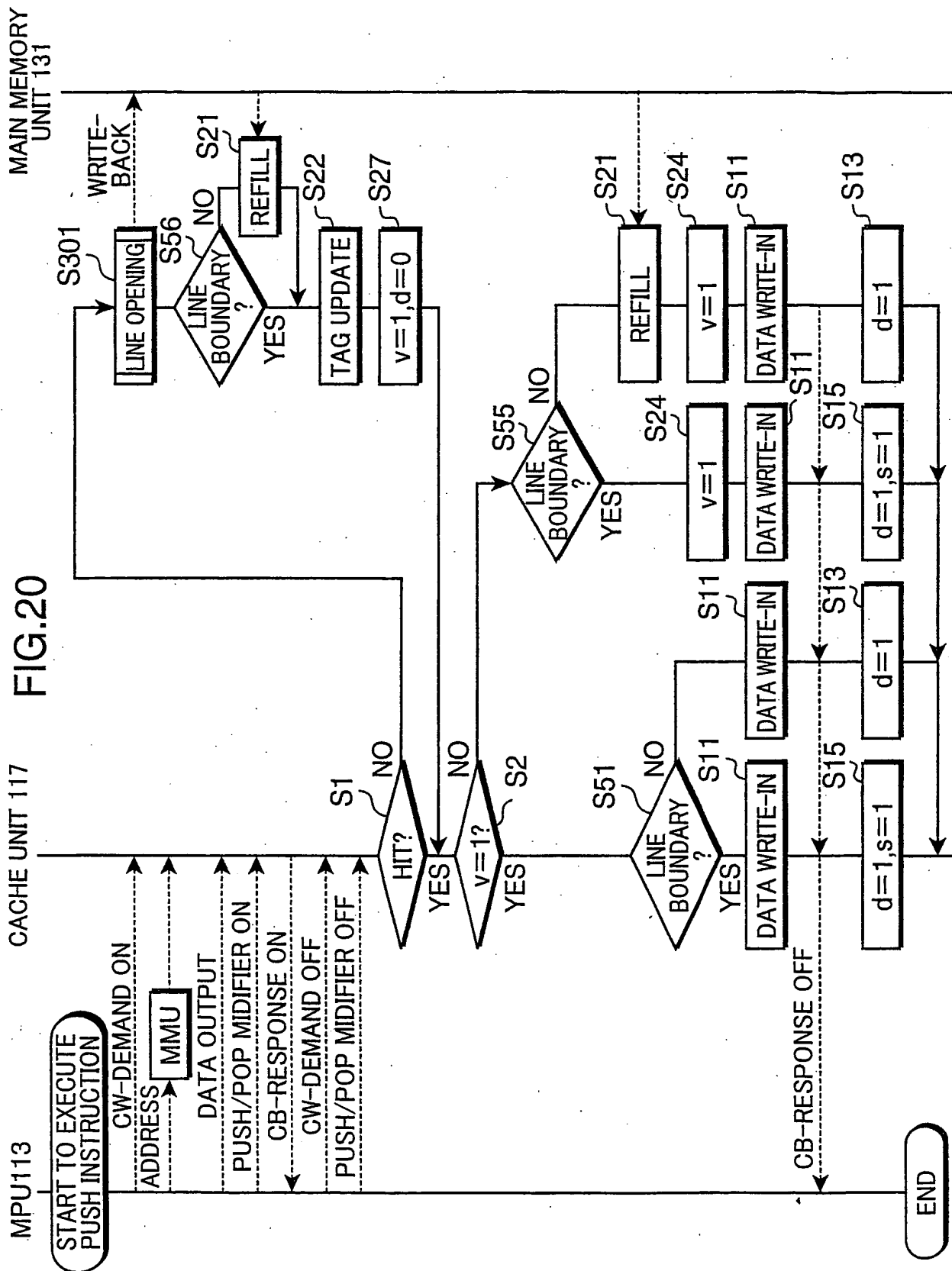


FIG.21

|     | LINE STATE    |            |            | OPERATION   |   |
|-----|---------------|------------|------------|---|---|
|     | VALID FLAG    | DIRTY FLAG | STACK FLAG | PUSH INTO THE HIGHEST ADDRESS   | PUSH INTO OTHER THAN THE HIGHEST ADDRESS  |
| (a) | NOT ALLOCATED |            |            | DECISION OF THE LINE TO BE OPENED, OPENING OF THE DECIDED LINE, v=1 d=0 s=0, OPERATION OF (b) | DECISION OF THE LINE TO BE OPENED, OPENING OF THE DECIDED LINE, REFILL, v=1 d=0 s=0, OPERATION OF (b) |
| (b) | 1             | 0          | 0          | DATA WRITE d=1 s=1  | DATA WRITE d=1  |
| (c) | 1             | 0          | 1          | DATA WRITE d=1  | DATA WRITE d=1  |
| (d) | 1             | 1          | 0          | DATA WRITE s=1  | DATA WRITE  |
| (e) | 1             | 1          | 1          | DATA WRITE  | DATA WRITE  |
| (f) | 0             | 0          | 0          | v=1<br>DATA WRITE d=1 s=1   | REFILL v=1<br>DATA WRITE d=1  |
| (g) | 0             | 0          | 1          | v=1<br>DATA WRITE d=1   | REFILL v=1<br>DATA WRITE d=1  |

FIG.22

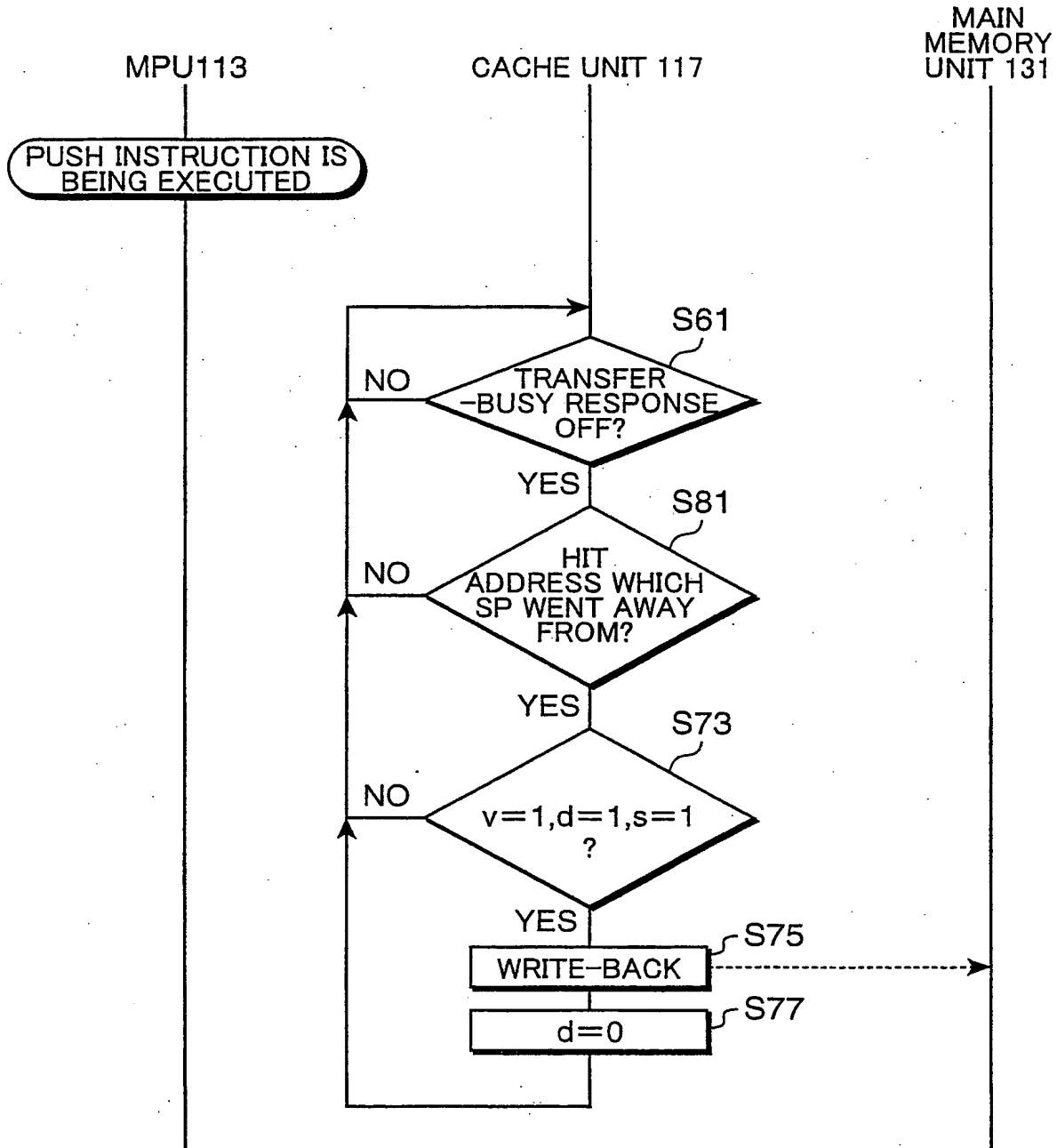


FIG.23

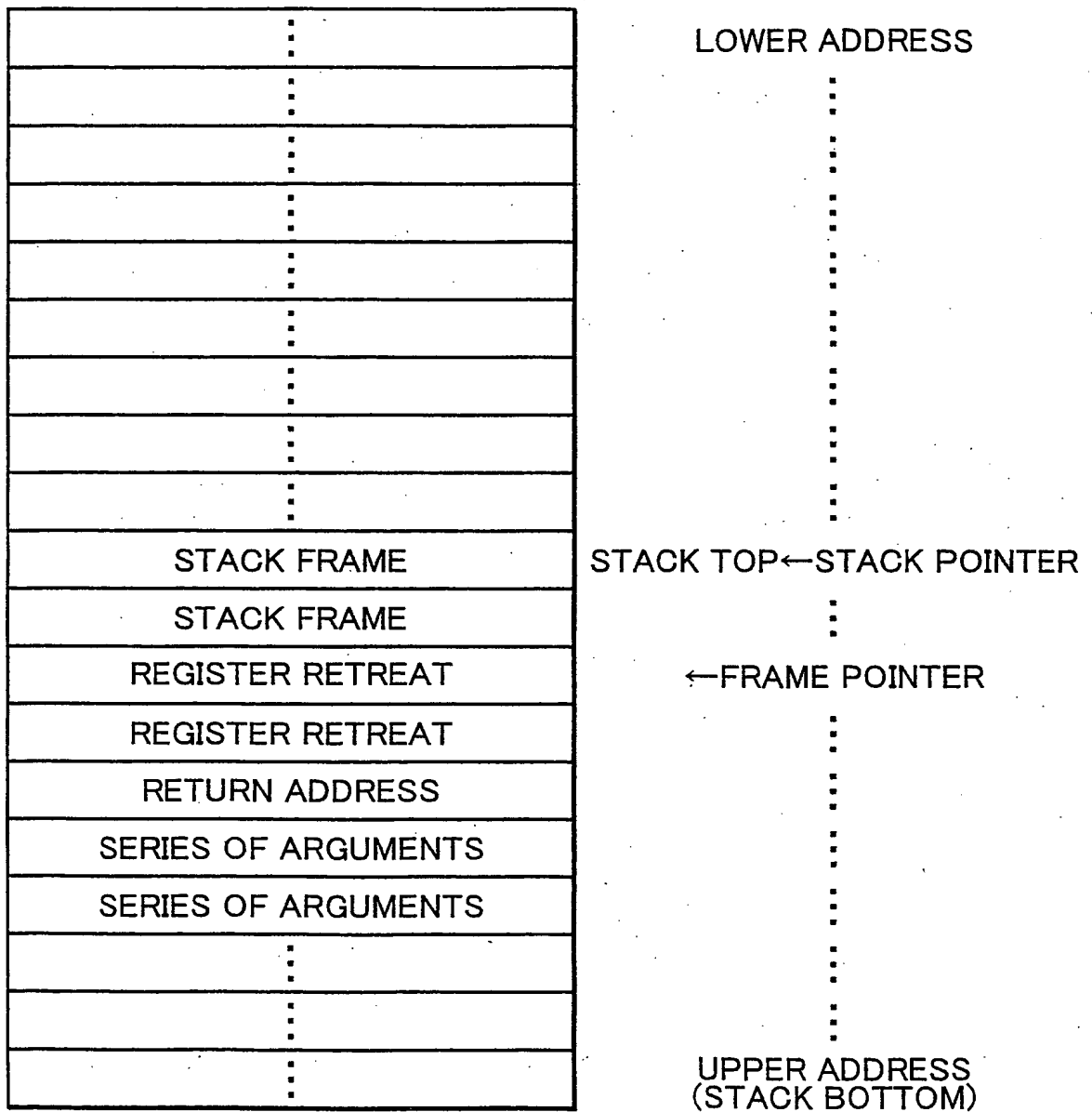


FIG.24

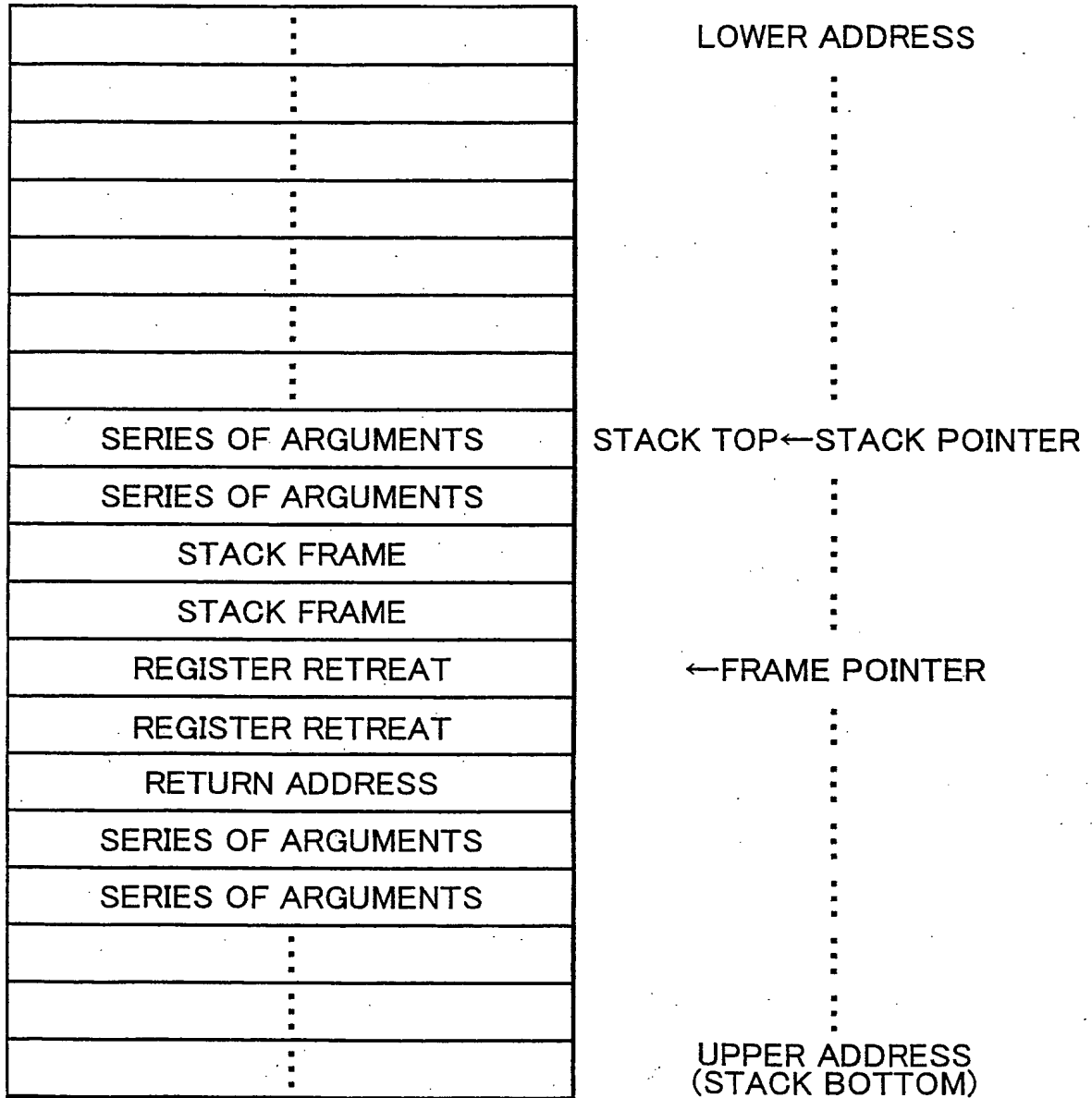




FIG.25

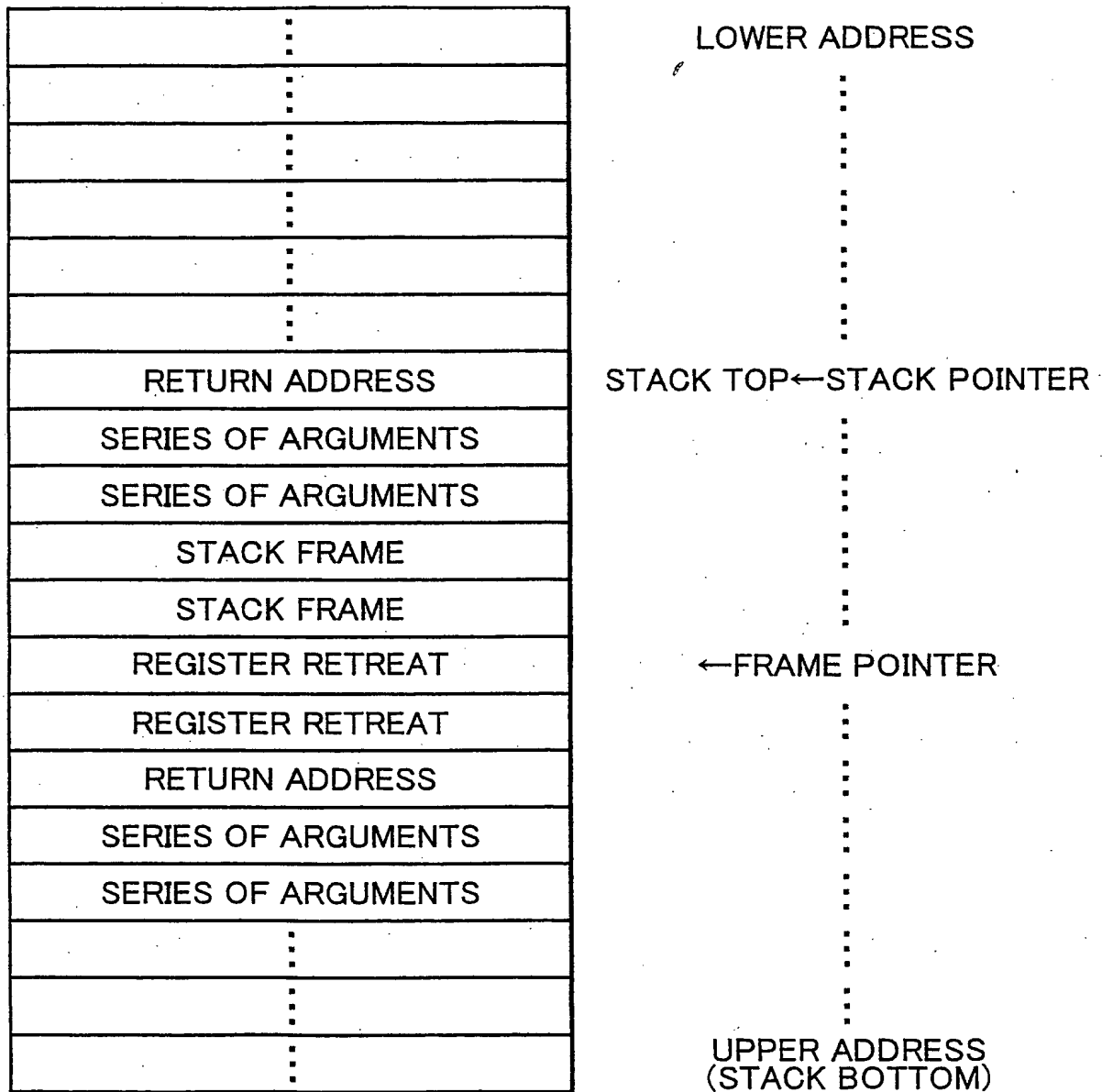


FIG.26

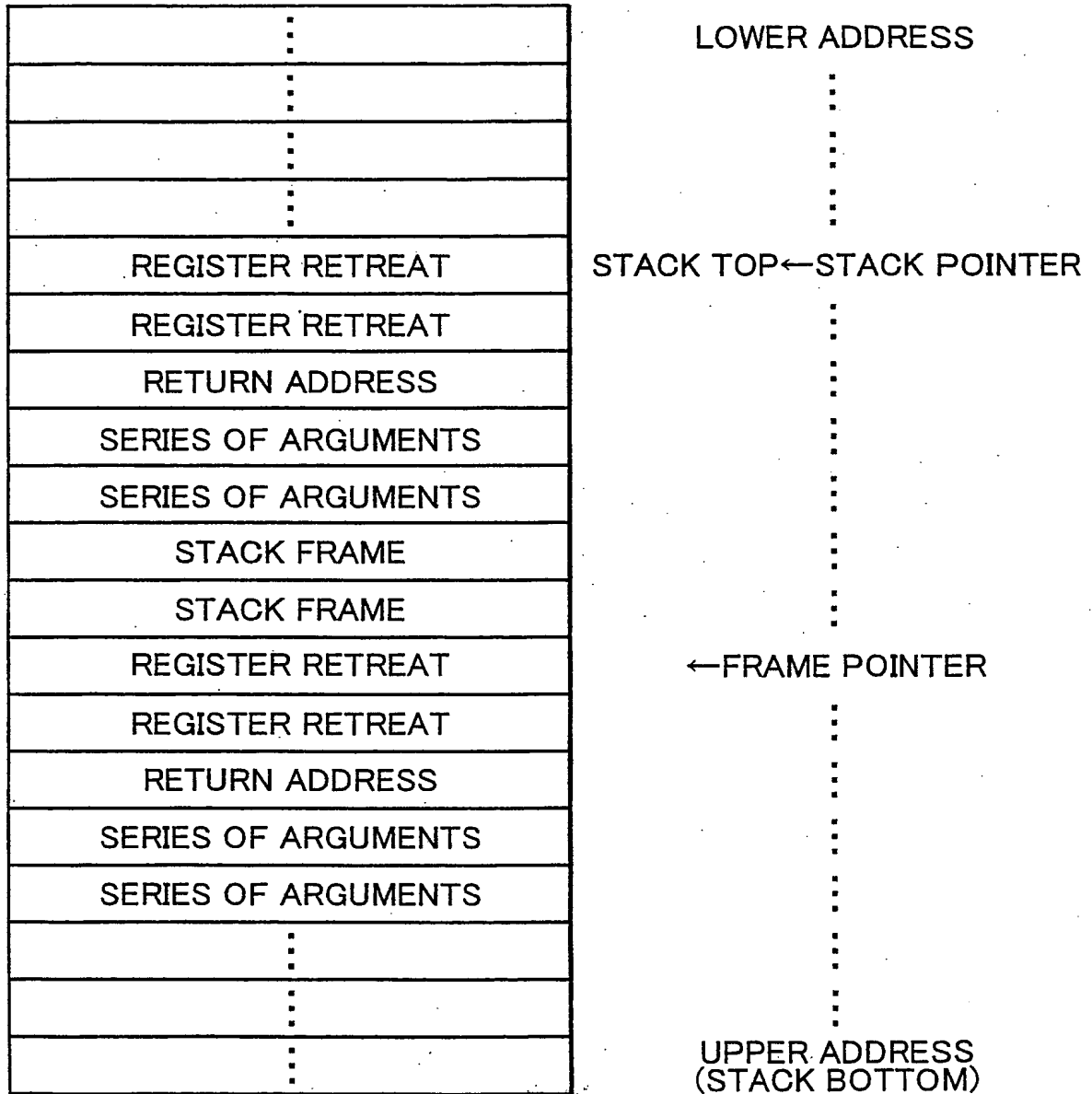


FIG.27

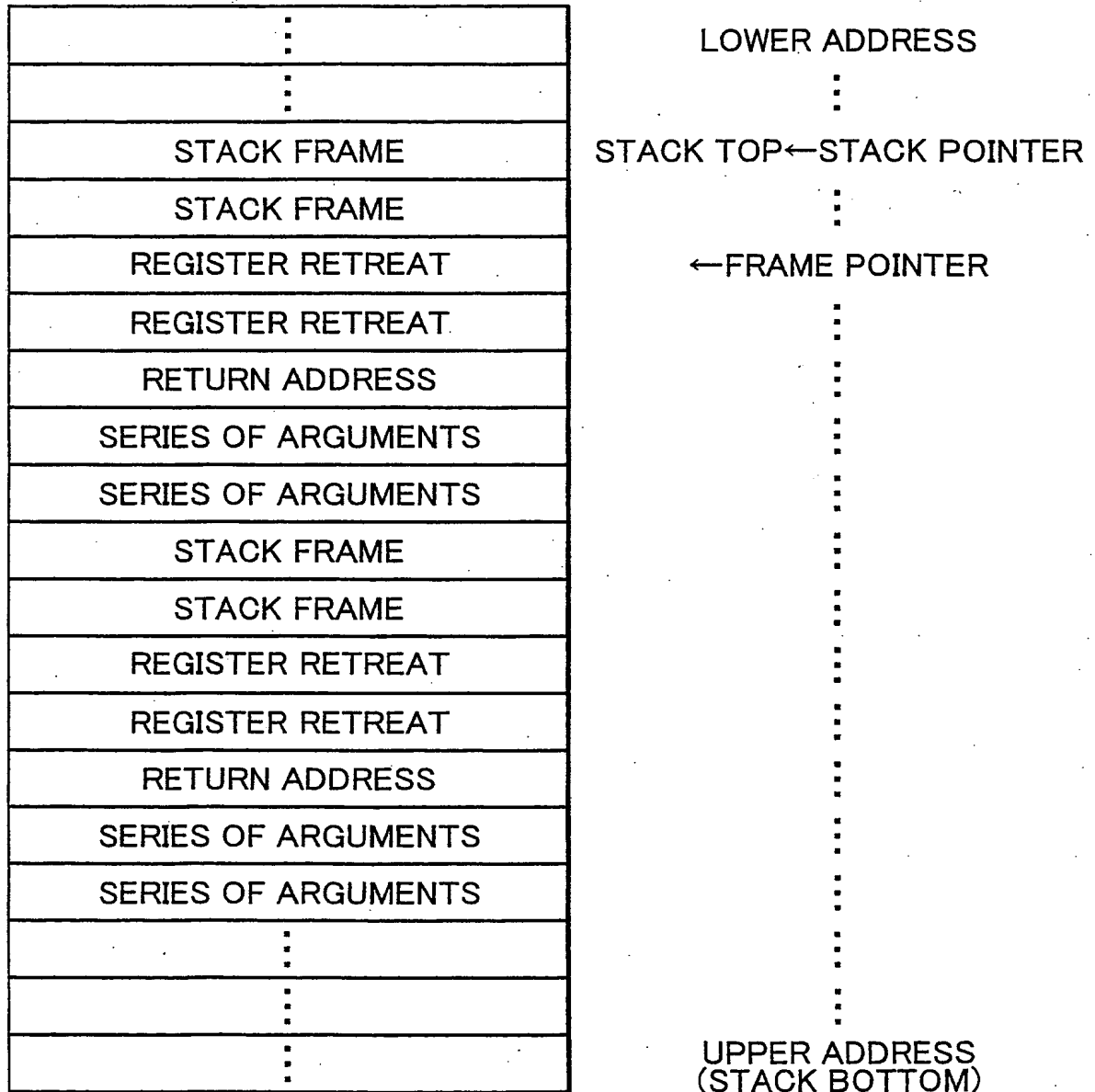


FIG.28

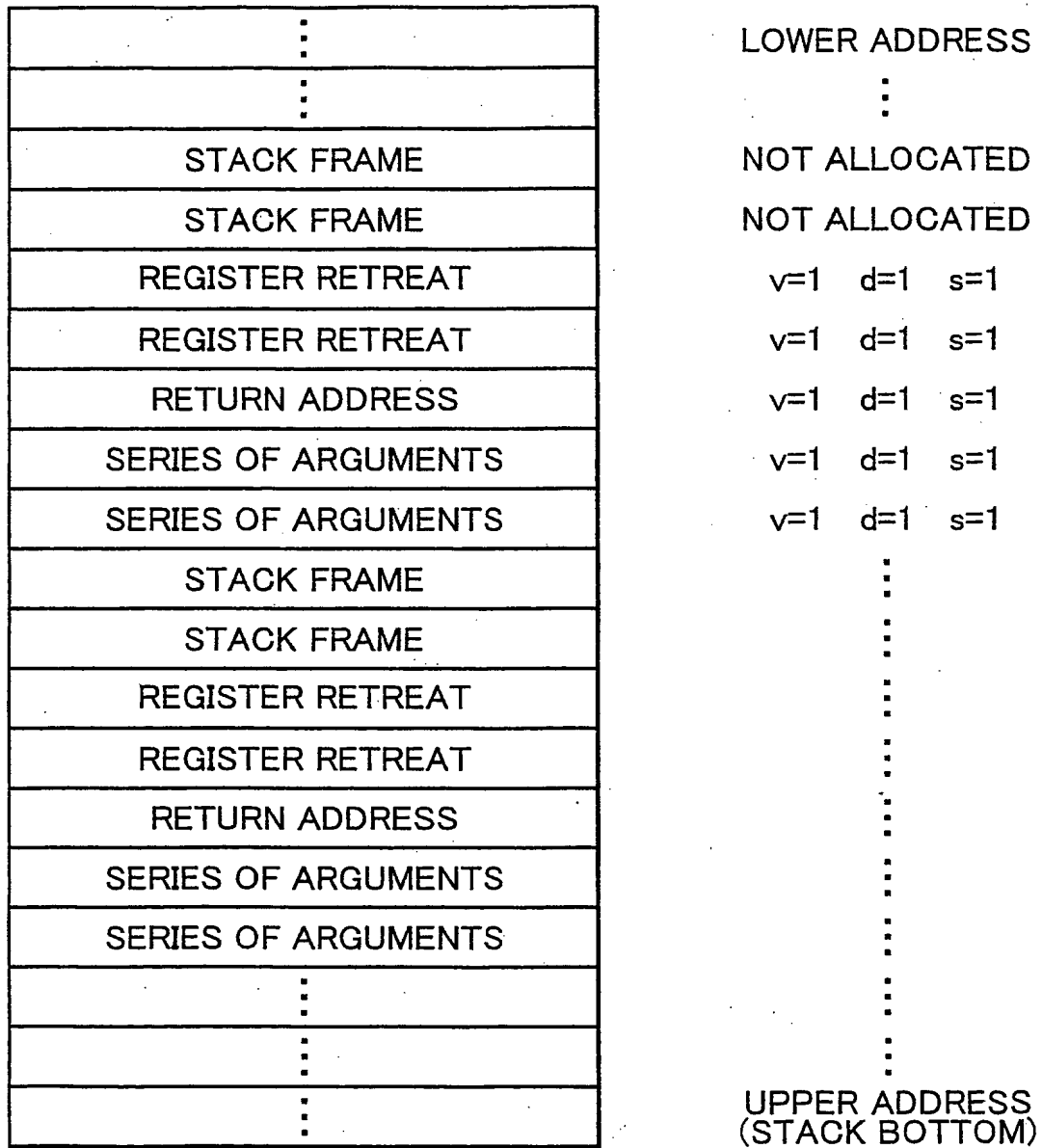


FIG.29

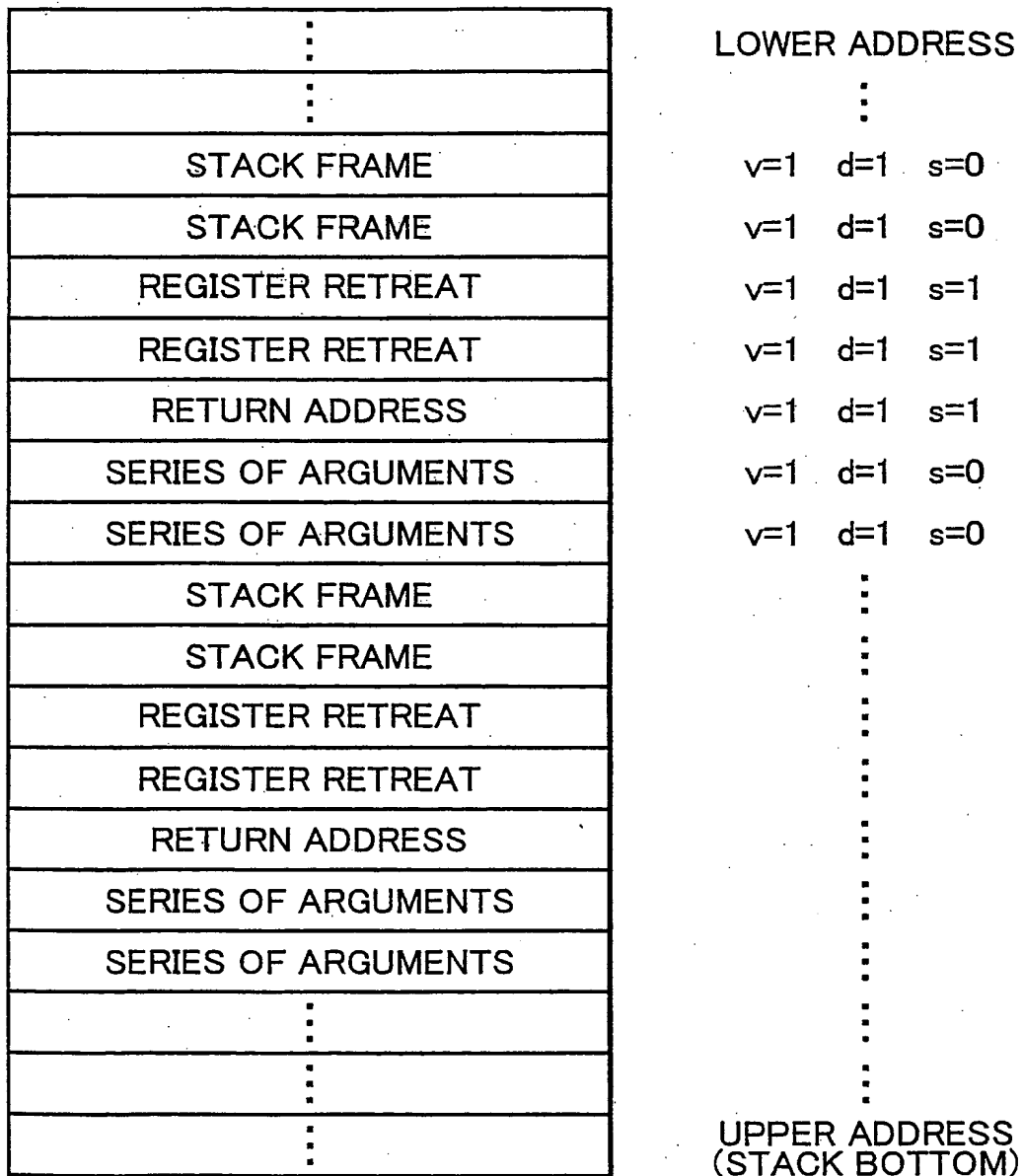


FIG.30

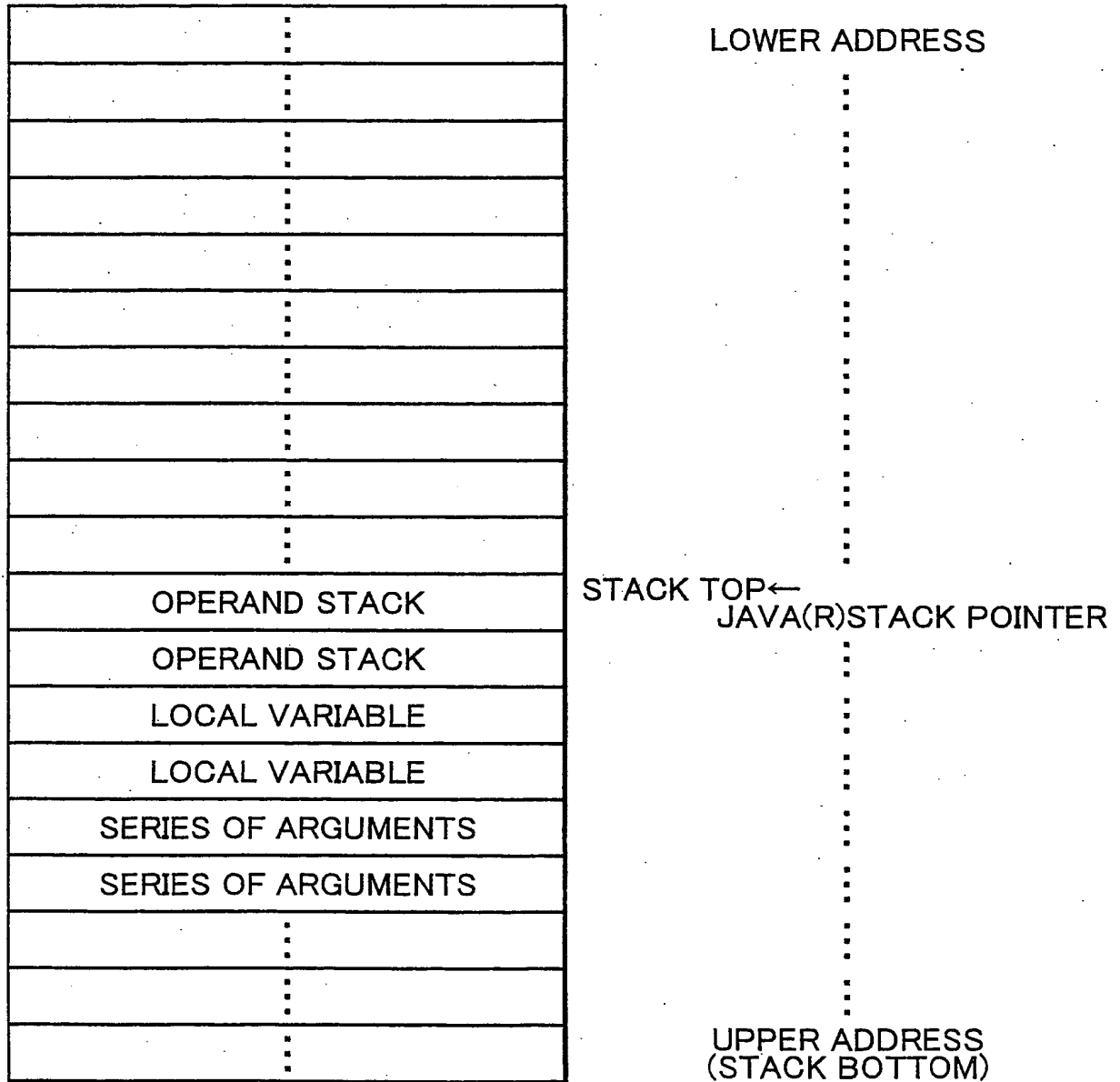


FIG.31

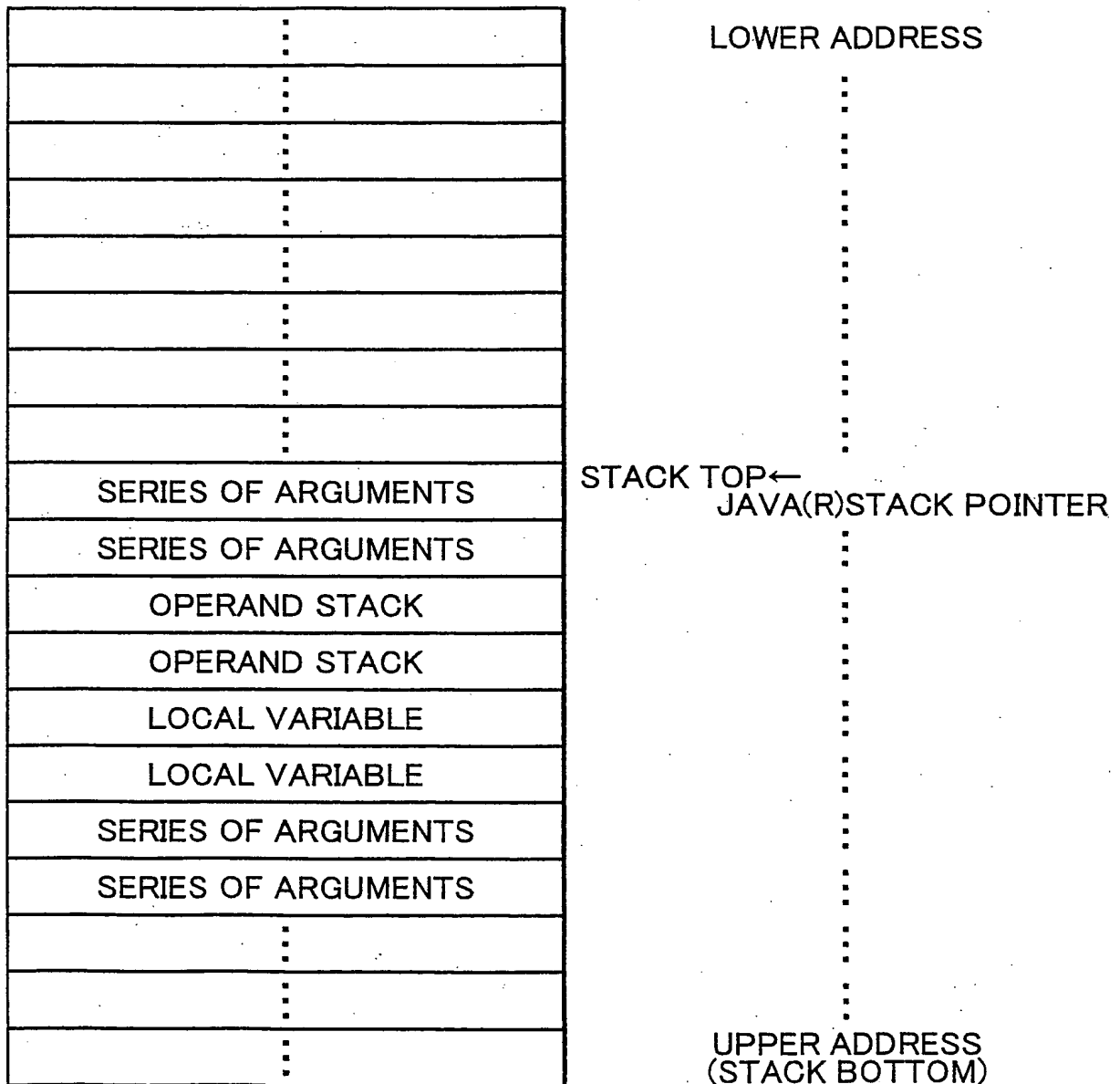


FIG.32

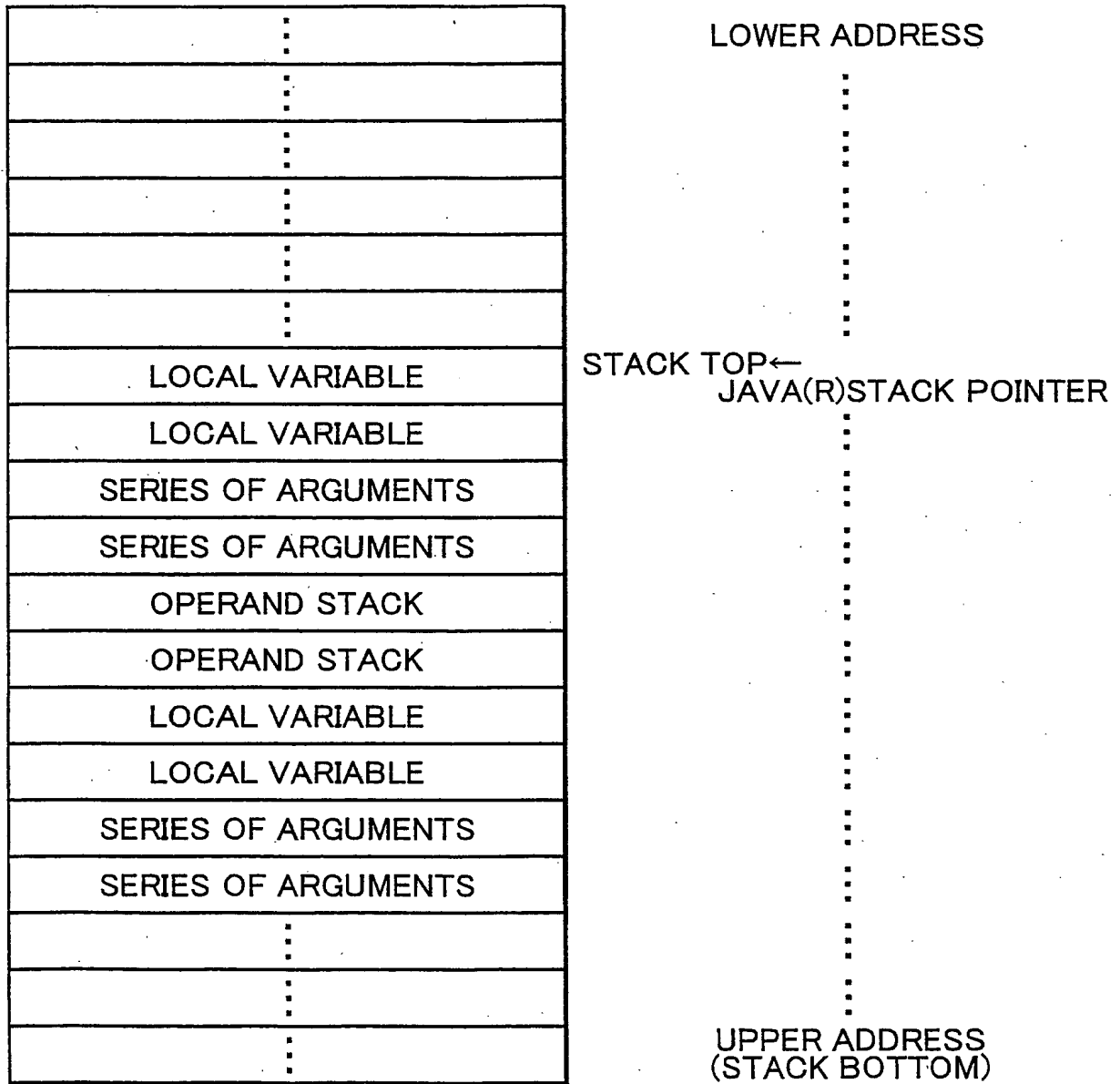




FIG.33

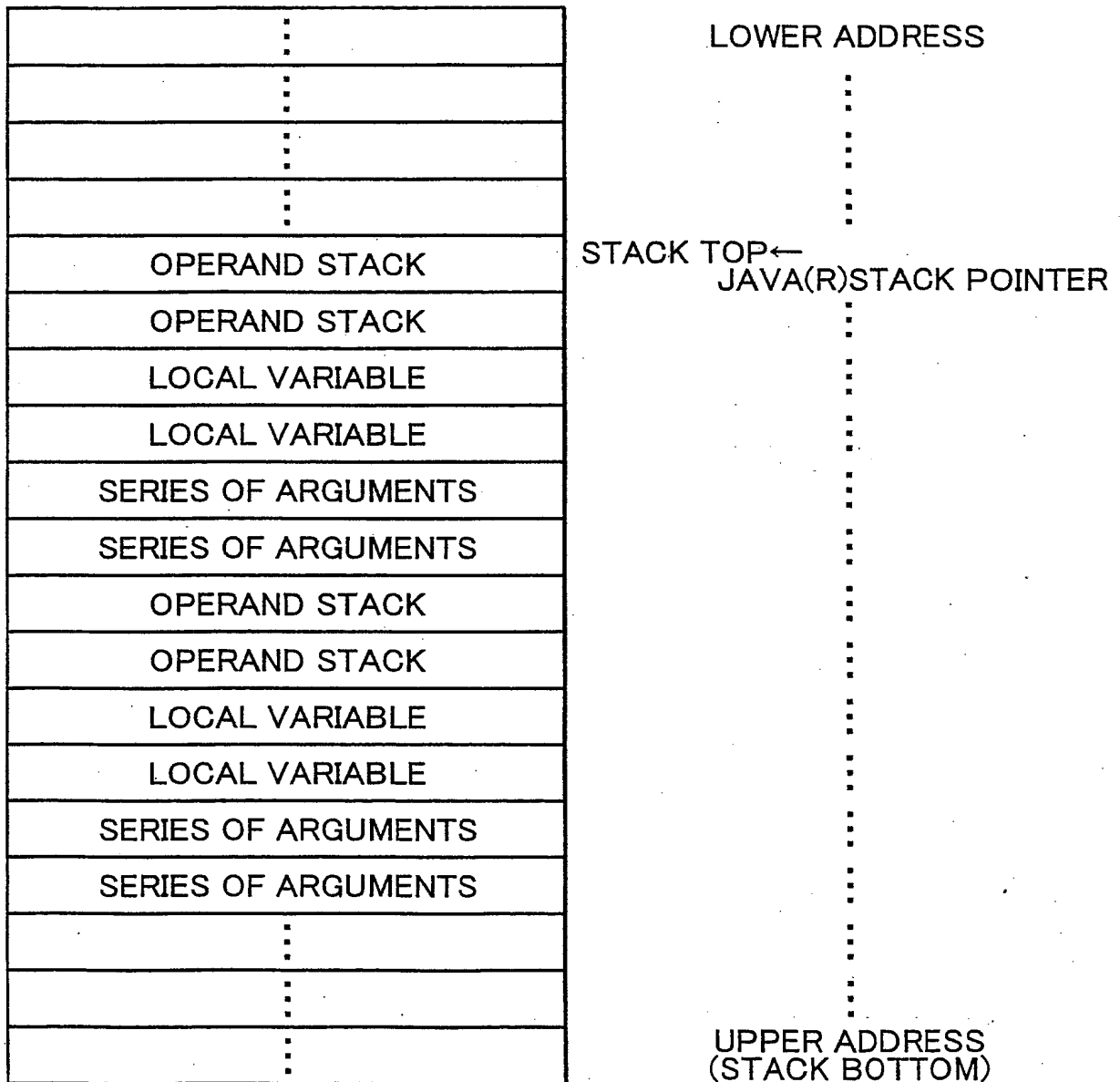


FIG.34

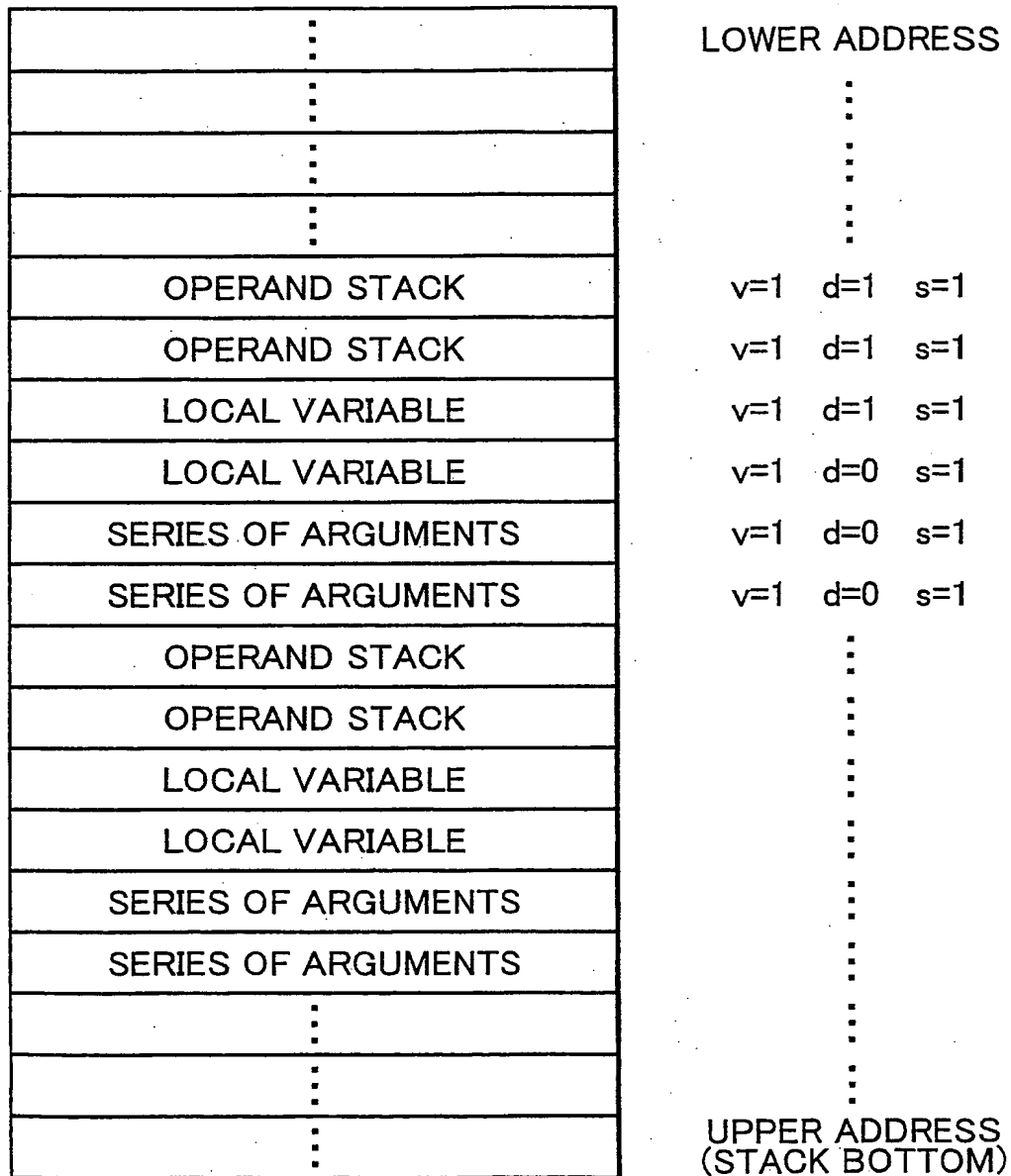


FIG.35

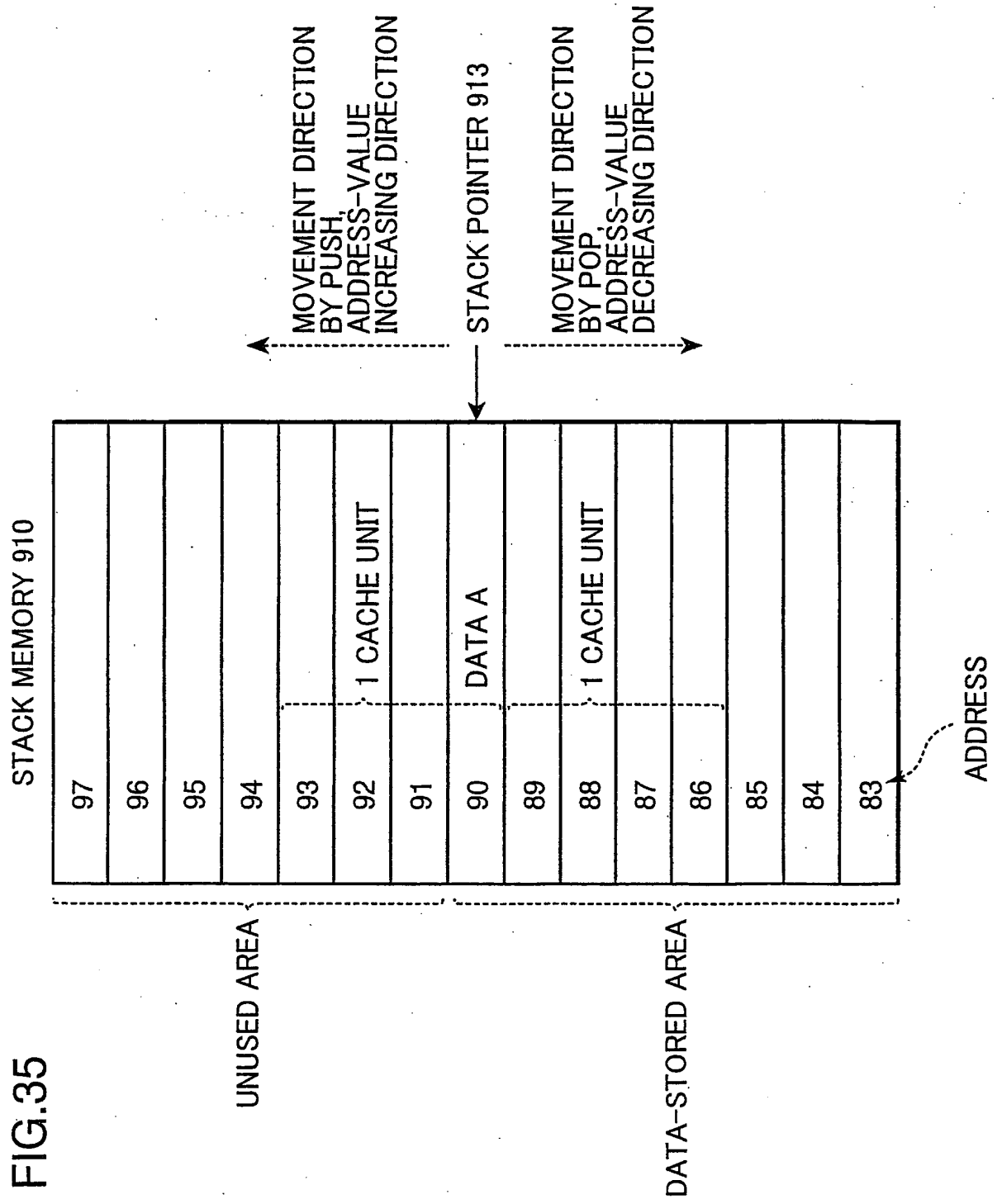


FIG.36

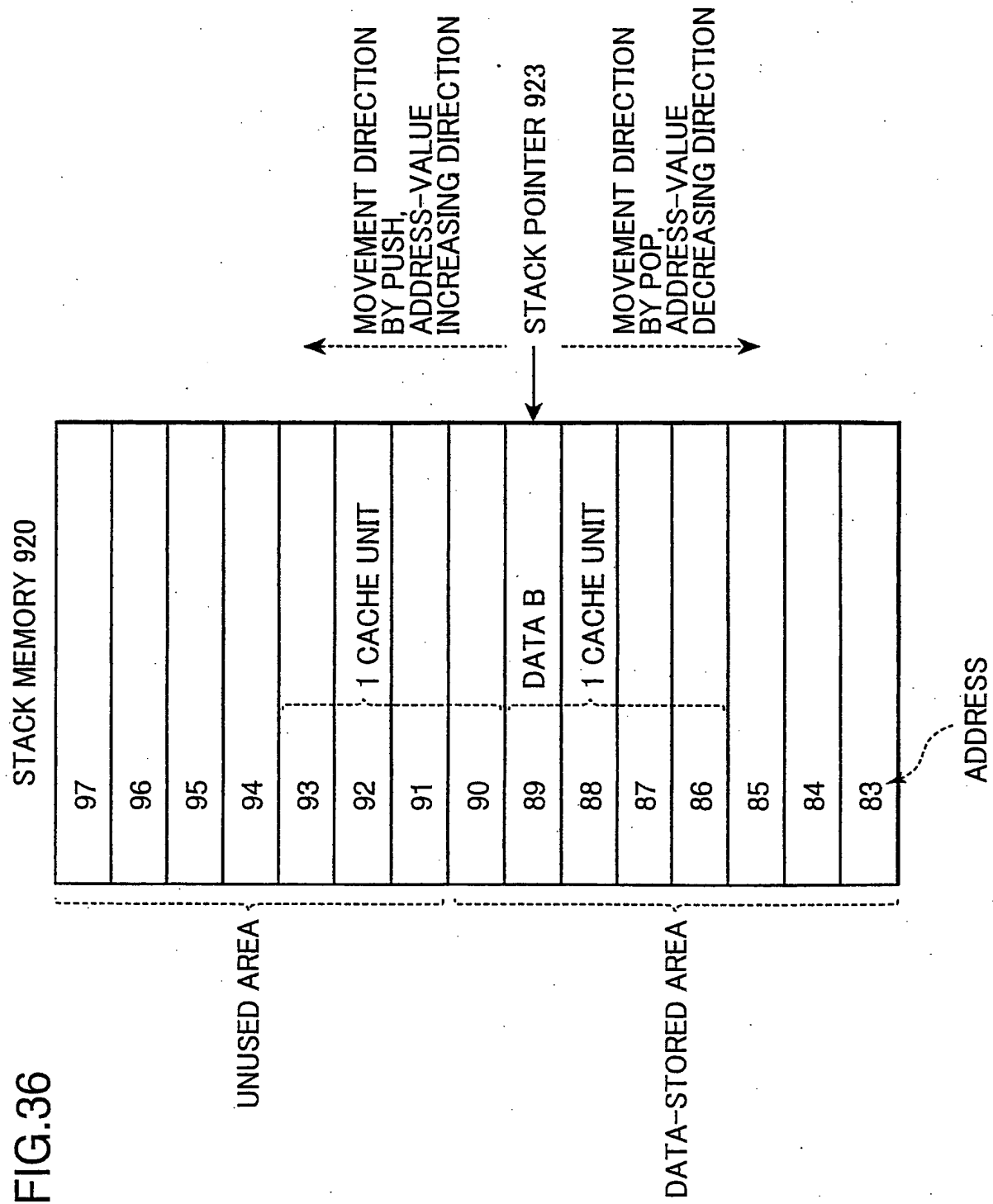


FIG.37

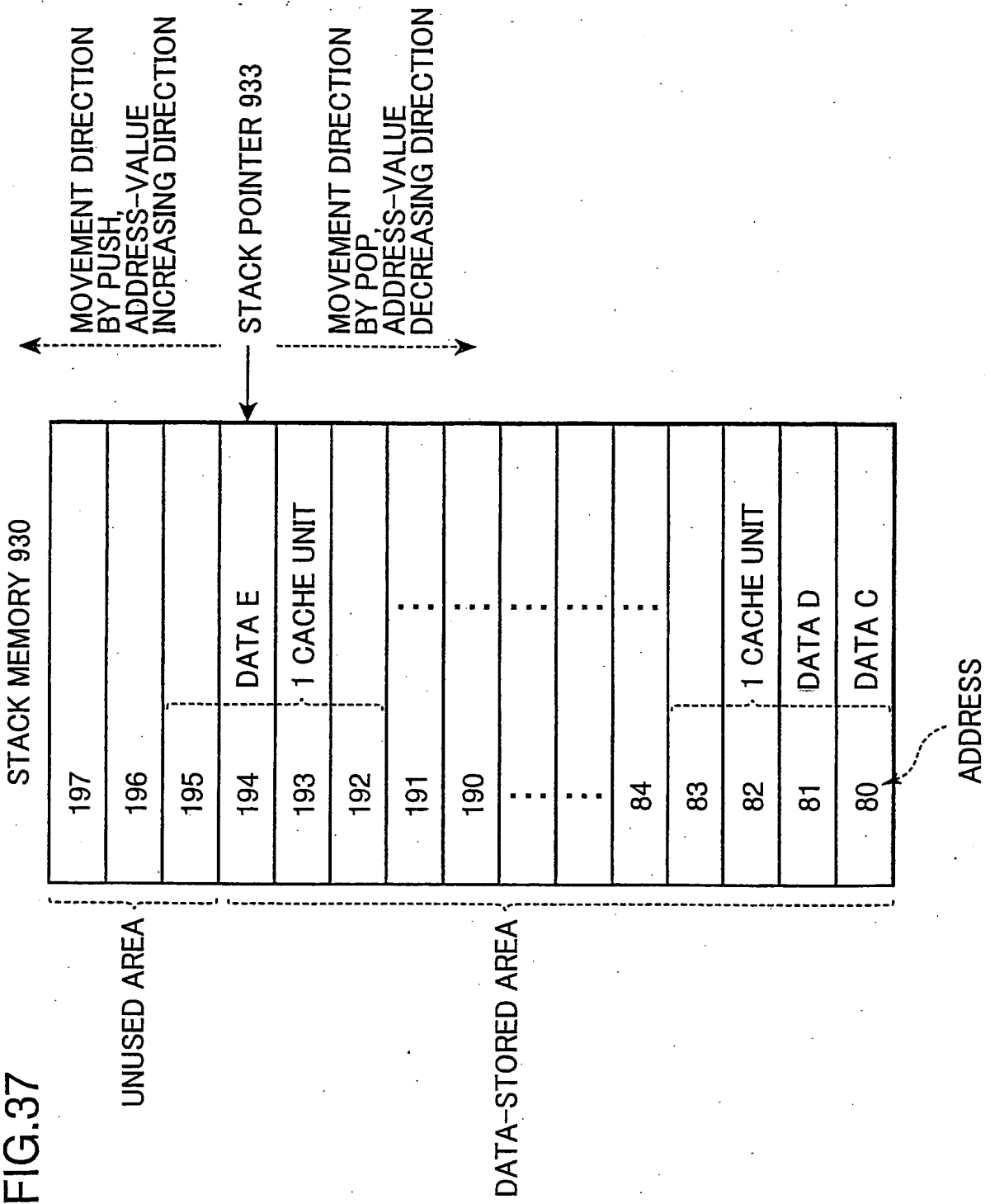


FIG.38

